

REFERENCES

- Adams J. B. (1974) Visible and near-infrared diffuse reflectance spectra of pyroxenes as applied to remote sensing of solid objects in the solar system. *J. Geophys. Res.*, 79, 4829–4836.
- Adams J. B. (1975) Interpretation of visible and near-infrared diffuse reflectance spectra of pyroxenes and other rock forming minerals. In *Infrared and Raman Spectroscopy of Lunar and Terrestrial Materials* (C. Karr, ed.), pp. 91–116. Academic, New York.
- Adams J. B. and McCord T. B. (1973) Vitrification darkening in the lunar highlands and identification of Descartes material at the Apollo 16 site. *Proc. Lunar Sci. Conf. 4th*, pp. 163–177.
- Adams J. B., Pieters C., and McCord T. B. (1974) Orange glass: Evidence for regional deposits of pyroclastic origin on the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 171–186.
- Adams J. B., Charette M. P., and Rhodes J. M. (1975) Chemical fractionation of the lunar regolith by impact melting. *Science*, 190, 380–381.
- Adams J. B., Hörz F., and Gibbons R. V. (1979) Effects of shock-loading on the reflectance spectra of plagioclase, pyroxene and glass (abstract). In *Lunar and Planetary Science X*, pp. 1–3. Lunar and Planetary Institute, Houston.
- Adams J. H. Jr. and Shapiro M. M. (1985) Irradiation of the Moon by galactic cosmic rays and other particles. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 315–327. Lunar and Planetary Institute, Houston.
- Adler I. and Trombka J. I. (1977) Orbital chemistry–lunar surface analysis from the X-ray and gamma-ray remote sensing experiments. *Phys. Chem. Earth*, 10, 17–43.
- Adler I., Trombka J., Gerard J., Schmadbeck R., Lowman P., Blodgett H., Yin L., Eller E., Lamoth R., Gorenstein P., Bjorkholm P., Harris B., and Gursky H. (1972) X-ray fluorescence experiment. In *Apollo 15 Preliminary Science Report*, pp. 17–1 to 17–17. NASA SP-289.
- Adler I., Trombka J. I., Schmadbeck R., Lowman P., Blodgett H., Yin L., Eller E., Podwysocki M., Weidner J. R., Bickel A. L., Lum R. K. L., Gerard J., Gorenstein P., Bjorkholm P., and Harris B. (1973) Results of the Apollo 15 and 16 X-ray experiment. *Proc. Lunar Sci. Conf. 4th*, pp. 2783–2791.
- Aggarwal H. R. and Oberbeck V. R. (1979) Monte Carlo simulation of lunar megaregolith and implications. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2689–2705.
- Agosto W. N. (1985) Electrostatic concentration of lunar soil minerals. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 453–464. Lunar and Planetary Institute, Houston.
- Agrell S. O., Peckett A., Boyd F. R., Haggerty S. E., Bunch T. E., Cameron E. N., Dence M. R., Douglas J. A. V., Plant A. G., Traill R. J., James O. B., Keil K., and Prinz M. (1970a) Titanian chromite, aluminum chromite, and chromian ulvöspinel from Apollo 11 rocks. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 81–86.
- Agrell S. O., Scoon J. H., Muir I. D., Long J. V. P., McConnell J. D. C., and Peckett A. (1970b) Observations on the chemistry, mineralogy and petrology of some Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 93–128.
- Ahrens T. J. and Cole D. M. (1974) Shock compression and adiabatic release of lunar fines from Apollo 17. *Proc. Lunar Sci. Conf. 5th*, pp. 2333–2345.
- Ahrens T. J. and O'Keefe J. D. (1977) Equations of state and impact-induced shock-wave interaction on the Moon. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 639–656. Pergamon, New York.
- Albee A. L. and Chodos A. A. (1970) Microprobe investigations on Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 135–157.
- Albee A. L., Chodos A. A., Gancarz A. J., Haines E. L., Papanastassiou D. A., Ray L., Tera F., Wasserburg G. J., and Wen T. (1972) Mineralogy, petrology, and chemistry of a Luna 16 basaltic fragment, sample B-1. *Earth Planet. Sci. Lett.*, 13, 353–367.
- Aldrin E. E. Jr., Armstrong N. A., and Collins M. (1969) Crew observations. In *Apollo 11 Preliminary Science Report*, pp. 35–39. NASA SP-214.
- Alexander E. C. Jr. and Kahl S. B. (1974) ⁴⁰Ar–³⁹Ar studies of lunar breccias. *Proc. Lunar Sci. Conf. 5th*, pp. 1353–1373.
- Alexander E. C. Jr., Coscio M. R. Jr., Dragon J. C., and Saito K. (1980) K/Ar dating of lunar soils IV: Orange glass from 74220 and agglutinates from 14259 and 14163. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1663–1677.
- Alexandrov A. K., Borisov B. M., Garin I. S., Grafov V. I., Ivanov A. G., Kotlov Yu. P., Komarov V. I., Kuleshov A. F., Mishkin V. K., Nikolayev G. B., Polenov L. N., Semenov P. S., and Yakovlev F. P. (1972) Investigations of mobility of Lunokhod 1. In *COSPAR Space Research XII*, pp. 73–82. Akademie-Verlag, Berlin.
- Ali M. Z. and Ehmman W. D. (1977) Chemical characterization of lunar core 60010. *Proc. Lunar Sci. Conf. 8th*, pp. 2967–2981.
- Allen C. C. (1975) Central peaks in lunar craters. *The Moon*, 12, 463–474.
- Allen R. O. Jr., Jovanovic S., and Reed G. W. Jr. (1974) A study of ²⁰⁴Pb partition in lunar samples using terrestrial and meteoritic analogues. *Proc. Lunar Sci. Conf. 5th*, pp. 1617–1623.
- Allen R. O., Jovanovic S., and Reed G. W. Jr. (1975) Agglutinates: Role in element and isotope chemistry and inferences regarding volatile-rich rock 66095 and glass 74220. *Proc. Lunar Sci. Conf. 6th*, pp. 2271–2279.
- Allton J. H. (1989) *Catalog of Apollo Lunar Surface Geological Sampling Tools and Containers*. NASA JSC Publ. No. 23454. 92 pp.
- Allton J. H. and Waltz S. R. (1980) Depth scales for Apollo 15, 16, and 17 drill cores. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1463–1477.
- Alvarez L. W., Alvarez W., Asaro F., and Michel H. V. (1980) Extraterrestrial cause for the Cretaceous-Tertiary mass extinction. *Science*, 208, 1095–1108.

- Alvarez R. (1973a) Lunar fines 74241,2, low frequency dielectric variations with density and temperature. *Eos Trans. AGU*, 54, 1129.
- Alvarez R. (1973b) Lunar powder simulator under lunarlike conditions, dielectric properties. *J. Geophys. Res.*, 78, 6833-6844.
- Alvarez R. (1974a) Dielectric comparison of lunar and terrestrial fines at lunar conditions. *J. Geophys. Res.*, 79, 5453-5457.
- Alvarez R. (1974b) Electrical properties of sample 70215 in the lunar temperature range of 100° to 373°K (abstract). In *Lunar Science V*, pp. 15-17. The Lunar Science Institute, Houston.
- Alvarez R. (1974c) Electrical properties of sample 70215; low frequency corrections. *Proc. Lunar Sci. Conf. 5th*, pp. 2663-2671.
- Alvarez R. (1974d) Lunar magnetization and surface charge variations (abstract). In *Lunar Interactions* (D. R. Criswell and J. W. Freeman, eds.), pp. 61-63. The Lunar Science Institute, Houston.
- Alvarez R. (1975) Lunar and terrestrial sample photoconductivity. *Proc. Lunar Sci. Conf. 6th*, pp. 3187-3197.
- Alvarez R. (1977a) On charge transport in the terminator's vicinity (abstract). In *Lunar Science VIII*, pp. 28-30. The Lunar Science Institute, Houston.
- Alvarez R. (1977b) Photoconductive effects on lunar and terrestrial fines. *Proc. Lunar Sci. Conf. 8th*, pp. 1277-1290.
- Anders E. (1968) Chemical processes in the early solar system, as inferred from meteorites. *Acc. Chem. Res.*, 1, 289-298.
- Anders E. (1978) Procrustean science: Indigenous siderophiles in the lunar highlands, according to Delano and Ringwood. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 161-184.
- Anders E. and Ebihara M. (1982) Solar-system abundances of the elements. *Geochim. Cosmochim. Acta*, 46, 2363-2380.
- Anders E., Ganapathy R., Keays R. R., Laul J. C., and Morgan J. W. (1971) Volatile and siderophile elements in lunar rocks: Comparison with terrestrial and meteoritic basalts. *Proc. Lunar Sci. Conf. 2nd*, pp. 1021-1036.
- Anders E., Ganapathy R., Krähenbühl U., and Morgan J. W. (1973) Meteoritic material on the Moon. *The Moon*, 8, 3-24.
- Anderson A. T. Jr. (1973) The texture and mineralogy of lunar peridotite 15445,10. *J. Geol.*, 81, 219-226.
- Anderson A. T. Jr. and Smith J. V. (1971) Nature, occurrence, and exotic origin of "gray mottled" (Luny Rock) basalts in Apollo 12 soils and breccias. *Proc. Lunar Sci. Conf. 2nd*, pp. 431-438.
- Anderson A. T. Jr., Bunch T. E., Cameron E. N., Haggerty S. E., Boyd F. R., Finger L. W., James O. B., Keil K., Prinz M., Ramdohr P., and El Goresy A. (1970) Armalcolite: A new mineral from the Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 55-63.
- Andre C. G., Bielefeld M. J., Eliason E., Soderblom L. A., Adler I., and Philpotts J. A. (1977) Lunar surface chemistry: A new imaging technique. *Science*, 197, 986-989.
- Annell C. S. and Helz A. W. (1970) Emission spectrographic determination of trace elements in lunar samples from Apollo 11. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 991-994.
- Apollo 15 Preliminary Examination Team (1972) Preliminary examination of lunar samples. In *Apollo 15 Preliminary Science Report*, pp. 6-1 to 6-25. NASA SP-289.
- Apollo Soil Survey (1971) Apollo 14: Nature and origin of rock types in soil from Fra Mauro Formation. *Earth Planet. Sci. Lett.*, 12, 49-54.
- Appleman D. E., Nissen H.-U., Stewart D. B., Clark J. R., Dowty E., and Huebner J. S. (1971) Studies of lunar plagioclases, tridymite, and cristobalite. *Proc. Lunar Sci. Conf. 2nd*, pp. 117-133.
- Arkani-Hamed J. (1973) On the thermal history of the Moon. *Proc. Lunar Sci. Conf. 4th*, pp. 2673-2684.
- Arkani-Hamed J. (1974) Lunar mascons as consequences of giant impacts. *The Moon*, 10, 307-322.
- Armstrong N., Collins M., and Aldrin E. E. (1970) *First on the Moon*. Little, Brown and Co., Boston. 511 pp.
- Armstrong T. W. and Alsmiller R. G. Jr. (1971) Calculation of cosmogenic radionuclides in the Moon and comparison with Apollo measurements. *Proc. Lunar Sci. Conf. 2nd*, pp. 1729-1745.
- Arndt J. and von Engelhardt W. (1987) Formation of Apollo 17 orange and black glass beads. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E372-E376.
- Arndt J., Flad K., and Feth M. (1979) Radiative cooling experiments on lunar glass analogues. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 355-373.
- Arndt J., Hummel W., and Gonzalez-Chabeza I. (1982) Diaplectic labradorite glass from the Manicouagan impact crater. *Phys. Chem. Minerals*, 8, 230-239.
- Arndt J., von Engelhardt W., Gonzales-Cabeza I., and Meier B. (1984) Formation of Apollo 15 green glass beads. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C225-C232.
- Arnold J. R. (1975) Monte Carlo simulation of turnover processes in the lunar regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 2375-2396.
- Arnold J. R. (1979) Ice in the lunar polar regions. *J. Geophys. Res.* 84, 5659-5668.
- Arnold J. R. (1987) Ice at the lunar poles revisited (abstract). In *Lunar and Planetary Science XVIII*, pp. 29-30. Lunar and Planetary Institute, Houston.
- Arnold J. R., Peterson L. E., Metzger A. E., and Trombka J. I. (1972) Gamma-ray spectrometer experiment. In *Apollo 15 Preliminary Science Report*, pp. 16-1 to 16-6. NASA SP-289.
- Arrhenius G. (1974) Electret formation on the lunar surface—adhesion and clustering of dielectric particles in the space environment (abstract). In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), p. 85. The Lunar Science Institute, Houston.

- Arvidson R., Crozaz G., Drozd R. J., Hohenberg C. M., and Morgan C. J. (1975a) Cosmic ray exposure ages of features and events at the Apollo landing sites. *The Moon*, 13, 67–79.
- Arvidson R., Drozd R. J., Hohenberg C. M., Morgan C. J., and Poupeau G. (1975b) Horizontal transport of the regolith, modification of features, and erosion rates on the lunar surface. *The Moon*, 13, 67–79.
- Arvidson R., Drozd R., Guinness E., Hohenberg C., Morgan C., Morrison R., and Oberbeck V. (1976) Cosmic ray exposure ages of Apollo 17 samples and the age of Tycho. *Proc. Lunar Sci. Conf. 7th*, pp. 2817–2832.
- Ashwal L. D. (1975) Petrologic evidence for a plutonic igneous origin of anorthositic clasts in 67955 and 77017. *Proc. Lunar Sci. Conf. 6th*, pp. 221–230.
- Ashwal L. D. (1990) *Anorthosites*. Springer-Verlag, New York, in press.
- Ashworth D. G. (1977) Lunar and planetary impact erosion. In *Cosmic Dust* (J. A. M. McDonnell, ed.), pp. 427–526. Wiley, New York.
- ASTM D 2487 (1987) Classification of soils for engineering purposes. *Standard Test Method, Vol. 04.08: Soil and Rock; Building Stones*, pp. 395–408. American Society for Testing and Materials, Philadelphia.
- Axon H. J. and Goldstein J. I. (1973) Metallic particles of high cobalt content in Apollo 15 soil samples. *Earth Planet. Sci. Lett.*, 18, 173–180.
- Baedecker P. A., Schaudy R., Elzie J. L., Kimberlin J., and Wasson J. T. (1971) Trace element studies of rocks and soils from Oceanus Procellarum and Mare Tranquillitatis. *Proc. Lunar Sci. Conf. 2nd*, pp. 1037–1061.
- Baedecker P. A., Chou C.-L., and Wasson J. T. (1972) The extralunar component in lunar soils and breccias. *Proc. Lunar Sci. Conf. 3rd*, pp. 1343–1359.
- Baedecker P. A., Chou C.-L., Grudewicz E. B., and Wasson J. T. (1973) Volatile and siderophilic trace elements in Apollo 15 samples: Geochemical implications and characterization of the long-lived and short-lived extralunar components. *Proc. Lunar Sci. Conf. 4th*, pp. 1177–1195.
- Baedecker P. A., Chou C.-L., Sundberg L. L., and Wasson J. T. (1974) Volatile and siderophilic trace elements in the soils and rocks of Taurus-Littrow. *Proc. Lunar Sci. Conf. 5th*, pp. 1625–1643.
- Bakos L., Chayka M., Cher L., Cheke A., Dogadkin N. N., Elek A., Kulchar K., Nagy D. L., Szabo E., Forzats B., and Zemplen E. (1977) Investigation of the composition of the Luna 16 sample. In *The Soviet American Conference on Cosmochemistry of the Moon and Planets* (J. H. Pomeroy and N. J. Hubbard, eds.), pp. 277–280. NASA SP-370.
- Baldrige W. S., Beaty D. W., Hill S. M. R., and Albee A. (1979) The petrology of the Apollo 12 pigeonite basalt suite. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 141–179.
- Baldwin R. B. (1963) *The Measure of the Moon*. Univ. of Chicago, Chicago. 488 pp.
- Baldwin R. B. (1974) On the origin of the mare basins. *Proc. Lunar Sci. Conf. 5th*, pp. 1–10.
- Baldwin R. B. (1981) On the origin of the planetesimals that produced the multi-ring basins. In *Multi-Ring Basins, Proc. Lunar Planet. Sci. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 19–28. Pergamon, New York.
- Bame S. J., Feldman W. C., Gosling J. T., Young D. T., and Zwickl R. D. (1983) What magnetospheric workers should know about solar wind composition. In *Energetic Ion Composition in the Earth's Magnetosphere* (R. G. Johnson, ed.), pp. 73–98. Terra, Tokyo.
- Bansal B. M., Church S. E., Gast P. W., Hubbard N. J., Rhodes J. M., and Wiesmann H. (1972) Chemical composition of soil from Apollo-16 and Luna-20 sites. *Earth Planet. Sci. Lett.*, 17, 29–35.
- Bansal B. M., Gast P. W., Hubbard N. J., Nyquist L. E., Rhodes J. M., Shih C. Y., and Weismann H. (1973) Lunar rock types (abstract). In *Lunar Science IV*, pp. 48–50. The Lunar Science Institute, Houston.
- Barraclough B. L. and Marti K. (1985) In search of the Moon's indigenous volatiles: Noble gases and nitrogen in vesicular lunar glasses (abstract). In *Lunar and Planetary Science XVI*, pp. 31–32. Lunar and Planetary Institute, Houston.
- Barsukov V. L. (1977) Preliminary data for the regolith core brought to earth by the automatic lunar station Luna 24. *Proc. Lunar Sci. Conf. 8th*, pp. 3303–3318.
- Barsukov V. L., Tarasov L. S., Dmitriev L. V., Kolesov G. M., Shevaleevsky I. D., and Garanin A. V. (1977) The geochemical and petrochemical features of regolith and rocks from Mare Crisium (preliminary data). *Proc. Lunar Sci. Conf. 8th*, pp. 3319–3332.
- Barsukov V. L., Dmitriev L. V., Tarasov L. S., Kolesov G. M., Shevaleevsky I. D., Ramendik G. A., and Garanin A. V. (1980) Geochemical and petrological peculiarities of regolith and lithic clasts from Mare Crisium. In *Lunar Soil from Mare Crisium* (V. L. Barsukov, ed.), pp. 158–165. Nauka, Moscow.
- Basford J. R., Dragon J. C., Pepin R. O., Coscio M. R., and Murthy V. R. (1973) Krypton and xenon in lunar fines. *Proc. Lunar Sci. Conf. 4th*, pp. 1915–1955.
- Basilevski A. T. (1976) On the evolution of small lunar craters. *Proc. Lunar Sci. Conf. 7th*, pp. 1005–1020.
- Basilevski A. T., Ivanov B. A., Florensky K. P., Yakolev O. I., Fel'dman V. I., Granovsky L. V., and Snadovskiy M. A. (1983) *Impact Craters on the Moon and Planets*. Nauka, Moscow. 200 pp. (Translated from Russian in NASA TM-77667.)
- Bassett H. L. and Shackelford R. G. (1972) Dielectric properties of Apollo 14 lunar samples at micrometer and millimeter wavelengths. *Proc. Lunar Sci. Conf. 3rd*, pp. 3157–3160.
- Basu A. (1976) Petrology of Holocene fluvial sand derived from plutonic source rocks: Implications to paleoclimatic interpretation. *J. Sed. Petrol.*, 46, 694–709.
- Basu A. (1977) Steady state, exposure age and growth of agglutinates in lunar soils. *Proc. Lunar Sci. Conf. 8th*, pp. 3617–3632.

- Basu A. and Bhattacharya R. N. (1986) A probabilistic approach to ballistite differentiation of surficial soils on moon-like planets (abstract). In *Lunar and Planetary Science XVII*, pp. 32–33. Lunar and Planetary Institute, Houston.
- Basu A. and Bower J. F. (1977) Provenance of Apollo 15 deep drill core sediments. *Proc. Lunar Sci. Conf. 8th*, pp. 2841–2867.
- Basu A. and McKay D. S. (1979) Petrography and provenance of Apollo 15 soils. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1413–1424.
- Basu A. and McKay D. S. (1984) Petrologic comparisons of Cayley and Descartes on the basis of Apollo 16 soils from Stations 4 and 11. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 89, B535–B541.
- Basu A. and McKay D. S. (1985) Chemical variability and origin of agglutinitic glass. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 90, D87–D94.
- Basu A., DesMarais D. J., Hayes J. M., and Meinschein W. G. (1975) Integrated investigation of the mixed origin of lunar sample 72161,11. *The Moon*, 14, 129–138.
- Basu A., McKay D. S., and Fruland R. M. (1978) Origin and modal petrography of Luna 24 soils. In *Mare Crisium: The View From Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 321–337. Pergamon, New York.
- Basu A., McKay D. S., Griffiths S., and Nace G. (1981) Regolith maturation on the Earth and the Moon with an example from Apollo 15. *Proc. Lunar Planet. Sci. 12B*, pp. 433–449.
- Bates R. L. and Jackson J. A., eds. (1980) *The Glossary of Geology*, 2nd edition. American Geological Institute, Washington. 751 pp.
- Bauer J. F. (1979) Experimental shock metamorphism of mono- and polycrystalline olivine: A comparative study. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2573–2596.
- Bean A. L., Conrad C. C. Jr., and Gordon R. F. (1970) Crew observations. In *Apollo 12 Preliminary Science Report*, p. 29–38. NASA SP-235.
- Beaty D. W. and Albee A. L. (1978) Comparative petrology and possible genetic relations among the Apollo 11 basalts. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 359–463.
- Beaty D. W. and Albee A. L. (1980) The geology and petrology of the Apollo 11 landing site. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 23–35.
- Beaty D. W., Hill S. M. R., Albee A., Ma M.-S., and Schmitt R. A. (1979) The petrology and chemistry of basaltic fragments from the Apollo 11 soil, Part 1. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 41–75.
- Becker R. H. (1980) Light elements in lunar soils revisited: Carbon, nitrogen, hydrogen, and helium. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1743–1761.
- Becker R. H. and Clayton R. N. (1975) Nitrogen abundances and isotopic compositions in lunar samples. *Proc. Lunar Sci. Conf. 6th*, pp. 2131–2149.
- Becker R. H. and Clayton R. N. (1977) Nitrogen isotopes in lunar soils as a measure of cosmic-ray exposure and regolith history. *Proc. Lunar Sci. Conf. 8th*, pp. 3685–3704.
- Becker R. H. and Epstein S. (1981) Carbon isotope ratios in some low- $\delta^{15}\text{N}$ lunar breccias. *Proc. Lunar Planet. Sci. 12B*, pp. 289–293.
- Becker R. H. and Pepin R. O. (1989) Long-term changes in solar wind elemental and isotopic ratios: A comparison of two lunar ilmenites of different antiquities. *Geochim. Cosmochim. Acta*, 53, 1135–1146.
- Becker R. H., Clayton R. N., and Mayeda T. K. (1976) Characterization of lunar nitrogen compounds. *Proc. Lunar Sci. Conf. 7th*, pp. 441–458.
- Beckmann P. (1965) Radar backscatter from the surface of the Moon. *J. Geophys. Res.*, 70, 2345–2350.
- Beckmann P. (1968) Depolarization of electromagnetic waves backscattered from the lunar surface. *J. Geophys. Res.*, 73, 649–655.
- Beckmann P. and Klemperer W. K. (1965) Interpretation of the angular dependence of backscattering from the Moon and Venus. *J. Res. Natl Bur. Stand.*, 69D, 1669–1677.
- Behrmann C., Crozaz G., Drozd R., Hohenberg C., Ralston C., Walker R., and Yuhas D. (1973) Cosmic-ray exposure history of North Ray and South Ray material. *Proc. Lunar Sci. Conf. 4th*, pp. 1957–1974.
- Bekker M. G. (1969) *Introduction to Terrain—Vehicle Systems*. Univ. of Michigan, Ann Arbor.
- Bell J. F. and Hawke B. R. (1981) The Reiner Gamma formation: Composition and origin as derived from remote sensing observations. *Proc. Lunar Planet. Sci. 12B*, pp. 679–694.
- Bell J. F. and Hawke B. R. (1984) Lunar dark-haloed impact craters: Origin and implications for early mare volcanism. *J. Geophys. Res.*, 89, 6899–6910.
- Bell P. M., Mao H. K., and Rossman G. R. (1975) Absorption spectroscopy of ionic and molecular units in crystals and glasses. In *Infrared and Raman Spectroscopy of Lunar and Terrestrial Minerals* (C. Karr, ed.), pp. 1–38. Academic, New York.
- Bell P. M., Mao H. K., and Weeks R. A. (1976) Optical spectra and electron paramagnetic resonance of lunar and synthetic glasses: A study of the effects of controlled atmosphere, composition, and temperature. *Proc. Lunar Sci. Conf. 7th*, pp. 2543–2559.
- Bence A. E. and Papike J. J. (1972) Pyroxenes as recorders of lunar basalt petrogenesis: Chemical trends due to crystal-liquid interaction. *Proc. Lunar Sci. Conf. 3rd*, pp. 431–469.
- Bence A. E., Papike J. J., and Prewitt C. T. (1970) Apollo 12 clinopyroxenes: Chemical trends. *Earth Planet. Sci. Lett.*, 8, 393–399.
- Berg O. E., Richardson F. F., and Burton H. (1973) Lunar ejecta and meteorites experiments. In *Apollo 17 Preliminary Science Report*, pp. 16–1 to 16–9. NASA SP-330.
- Berg O. E., Richardson F. F., Rhee J. W., and Auer S. (1974) Preliminary results of a cosmic dust experiment on the Moon. *Geophys. Res. Lett.*, 7, 289–230.

- Bernatowicz T., Drozd R. J., Hohenberg C. M., Lugmair G., Morgan C. J., and Podosek F. A. (1977) The regolith history of 14307. *Proc. Lunar Sci. Conf. 8th*, pp. 2763–2783.
- Bernatowicz T. J., Hohenberg C. M., Hudson B., Kennedy B. M., and Podosek F. A. (1978) Argon ages for lunar breccias 14064 and 15405. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 905–919.
- Bhandari N. and Padia J. T. (1974a) On the variation of the cosmic ray composition in the past. *Proc. Lunar Sci. Conf. 5th*, pp. 2577–2589.
- Bhandari N. and Padia J. T. (1974b) Secular variations in the abundances of heavy nuclei in cosmic rays. *Science*, 185, 1043–1045.
- Bhandari N., Goswami J. N., Gupta S. K., Lal D., Tamhane A. S., and Venkatavaradan V. S. (1972) Collision controlled radiation history of the lunar regolith. *Proc. Lunar Sci. Conf. 3rd*, pp. 2811–2829.
- Bhogeswara Rao D., Choudray U. V., Erstfeld T. E., Williams R. J., and Chang Y. A. (1979) Extraction processes for the production of aluminum, titanium, iron, magnesium, and oxygen from nonterrestrial sources. In *Space Resources and Space Settlements* (J. Billingham et al., eds.), pp. 257–274. NASA SP-428.
- Bianco A. and Taylor L. (1977) Applications of dynamic crystallization studies: Lunar olivine-normative basalts. *Proc. Lunar Sci. Conf. 8th*, pp. 1593–1610.
- Bibring J. P., Burlingame A. L., Langevin Y., Maurette M., and Wszolek P. C. (1974a) Simulation in lunar carbon chemistry: II. Lunar winds contribution. *Proc. Lunar Sci. Conf. 5th*, pp. 1763–1784.
- Bibring J. P., Burlingame A. L., Chaumont J., Langevin Y., Maurette M., and Wszolek P. C. (1974b) Simulation of lunar carbon chemistry: I. Solar wind contribution. *Proc. Lunar Sci. Conf. 5th*, pp. 1747–1762.
- Bickel C. E., Warner J. L., and Phinney W. C. (1976) Petrology of 79215: brecciation of a lunar cumulate. *Proc. Lunar Sci. Conf. 7th*, pp. 1793–1819.
- Bielefeld M. J., Reedy R. C., Metzger A. E., Trombka J. I., and Arnold J. R. (1976) Surface chemistry of selected lunar regions. *Proc. Lunar Sci. Conf. 7th*, pp. 2661–2676.
- Bills B. G. and Ferrari A. J. (1976) Lunar crustal thickness. *Proc. Lunar Sci. Conf. 7th*, frontispiece.
- Binder A. B. (1978) On fission and the devolatilization of a Moon of fission origin. *Earth Planet. Sci. Lett.*, 41, 381–385.
- Binder A. B. (1982) The Moon: Its figure and orbital evolution. *J. Geophys. Res. Lett.*, 9, 33–36.
- Binder A. B. (1986) The initial thermal state of the Moon. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds.), pp. 425–433. Lunar and Planetary Institute, Houston.
- Binder A. B. and Gunga H.-C. (1985) Young thrust-fault scarps in the highlands: Evidence for an initially totally molten Moon. *Icarus*, 63, 421–441.
- Binder A. B. and Lange M. A. (1980) On the thermal history, thermal state, and related tectonism of a Moon of fission origin. *J. Geophys. Res.*, 85, 3194–3208.
- Bird M. L. (1971) Distribution of trace elements in olivines and pyroxenes—an experimental study. Ph.D. thesis, Univ. of Missouri, Rolla. 249 pp.
- Bishop A. W. (1955) The use of the slip circle in the stability analysis of earth slopes. *Geotechnique*, 5, 7–17.
- Blacic J. D. (1985) Mechanical properties of lunar materials under anhydrous, hard vacuum conditions: Applications of lunar glass structural components. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 487–495. Lunar and Planetary Institute, Houston.
- Blanchard D. P. and Budahn J. R. (1978) Chemistry of orange/black soils from core 74001/2. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1969–1980.
- Blanchard D. P., Haskin L. A., Jacobs J. W., Brannon J. C., and Korotev R. (1975a) Major and trace element chemistry of Boulder 1 at Station 2, Apollo 17. *The Moon* 14, 359–371.
- Blanchard D. P., Korotev R. L., Brannon J. C., Jacobs J. W., Haskin L. A., Reid A. M., Donaldson C. H., and Brown R. W. (1975b) A geochemical and petrographic study of 1–2-mm fines from Apollo 17. *Proc. Lunar Sci. Conf. 6th*, pp. 2321–2341.
- Blanchard D. P., Jacobs J. W., Brannon J. C., and Haskin L. A. (1976) Major and trace element composition of matrix and aphanitic clasts from consortium breccia 73215. *Proc. Lunar Sci. Conf. 7th*, pp. 2179–2187.
- Blanchard D. P., Jacobs J. W., and Brannon J. C. (1977) Chemistry of ANT-suite and felsite clasts from consortium breccia 73215 and of gabbroic anorthosite 79215. *Proc. Lunar Sci. Conf. 8th*, pp. 2507–2524.
- Blanchard D. P., Brannon J. C., Aaboe E., and Budahn J. R. (1978) Major and trace element chemistry of Luna 24 samples from Mare Crisium. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 613–630. Pergamon, New York.
- Blanford G. E. (1980) Cosmic ray production curves below reworking zones. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1357–1368.
- Blanford G. E. (1982) Solar-wind irradiation effects on ilmenite (abstract). In *Lunar and Planetary Science XIII*, pp. 47–48. Lunar and Planetary Institute, Houston.
- Blanford G. E., Fruland R. M., and Morrison D. A. (1975) Long-term differential energy spectrum for solar-flare iron-group particles. *Proc. Lunar Sci. Conf. 6th*, pp. 3557–3576.
- Blanford G. E., Blanford J., and Hawkins J. A. (1979) Irradiation stratigraphy and depositional history of the Apollo 16 double drive tube 60009/10. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1333–1349.
- Blau P. J. and Goldstein J. I. (1975) Investigation and simulation of metallic spherules from lunar soils. *Geochim. Cosmochim. Acta*, 39, 309–324.
- Bobrov V. A., Bolotov V. V., Gulbert E. N., Parkhomenko V. S., and Shipitsin Yu. G. (1980) Instrumental neutron activation studies of elemental composition of lunar regolith. In *Lunar Soil from Mare Crisium* (V. L. Barsukov, ed.), pp. 345–351. Nauka, Moscow.

- Bogard D. D. and Hirsch W. C. (1975) Noble gas studies on grain size separates of Apollo 15 and 16 deep drill cores. *Proc. Lunar Sci. Conf. 6th*, pp. 2057-2084.
- Bogard D. D. and Hirsch W. C. (1977) Noble gas evidence for the depositional and irradiational history of 60010-60009 core soils. *Proc. Lunar Sci. Conf. 8th*, pp. 2983-2999.
- Bogard D. D. and Nyquist L. E. (1973) $^{40}\text{Ar}/^{36}\text{Ar}$ variations in Apollo 15 and 16 regolith. *Proc. Lunar Sci. Conf. 4th*, pp. 1975-1985.
- Bogard D. D., Hirsch W. C., and Nyquist L. E. (1974) Noble gases in Apollo 17 fines: Mass fractionation effects in trapped Xe and Kr. *Proc. Lunar Sci. Conf. 5th*, pp. 1975-2003.
- Bogard D. D., McKay D. S., Morris R. V., Wentworth S. J., and Johnson P. (1985) Regolith breccias from Apollo 15 and 16: Petrology, rare gases, and FMR maturity (abstract). In *Lunar and Planetary Science XVI*, pp. 73-74. Lunar and Planetary Institute, Houston.
- Bohren C. F. and Huffman D. R. (1983) *Absorption and Scattering of Light by Small Particles*. Wiley, New York. 530 pp.
- Borchardt R., Knoll H.-D., Bischoff A., Ostertag R., and Stöffler D. (1985) *Microprobe Analyses of Apollo 14 and 16 Lunar Minerals and Rocks*. Institute of Mineralogy, University of Münster. 141 pp.
- Borchardt R., Stöffler D., Spettel B., Palme H., Wänke H., Wacker K., and Jessberger E. K. (1986) Composition, structure, and age of the Apollo 16 subregolith basement as deduced from the chemistry of post-Imbrium melt bombs. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E43-E54.
- Borg J., Chaumont J., Jouret C., Langevin Y., and Maurette M. (1980) Solar wind radiation damage in lunar dust grains and the characteristics of the ancient solar wind. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 431-461. Pergamon, New York.
- Bouchet M., Kaplan G., Voudon A., and Bertolotti M.-J. (1971) Spark mass spectrometric analysis of major and minor elements in six lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1247-1252.
- Bowell E., Dollfus A., Zellner B., and Geake J. E. (1973) Polarimetric properties of the lunar surface and its interpretation Part 6: Albedo determinations from polarimetric characteristics. *Proc. Lunar Sci. Conf. 4th*, pp. 3167-3174.
- Bowin C., Simon B., and Wollenhaupt W. R. (1975) Mascons: A two-body solution. *J. Geophys. Res.*, 80, 4947-4955.
- Bowker D. E. and Hughes J. K. (1971) *Lunar Orbiter Photographic Atlas of the Moon*. NASA SP-206. 675 pp.
- Boyce J. M. (1976) Ages of flow units in the lunar nearside maria based on Lunar Orbiter IV photographs. *Proc. Lunar Sci. Conf. 7th*, pp. 2717-2728.
- Boyce J. M. and Johnson D. A. (1978) Ages of flow units in the far eastern maria and implications for basin-filling history. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3275-3283.
- Boyd F. R. and Smith D. (1971) Compositional zoning in pyroxenes from lunar rock 12021, Oceanus Procellarum. *J. Petrol.*, 12, 439-464.
- Boynton W. V. and Hill D. H. (1983) Composition of bulk samples and a pristine clast from Allan Hills A81005. *Geophys. Res. Lett.*, 10, 837-840.
- Boynton W. V. and Wasson J. T. (1977) Distribution of 28 elements in size fractions of lunar mare and highlands soils. *Geochim. Cosmochim. Acta*, 41, 1073-1082.
- Boynton W. V., Baedeker P. A., Chou C.-L., Robinson K. L., and Wasson J. T. (1975) Mixing and transport of lunar surface materials: Evidence obtained by the determination of lithophile, siderophile, and volatile elements. *Proc. Lunar Sci. Conf. 6th*, pp. 2241-2259.
- Boynton W. V., Chou C.-L., Robinson K. L., Warren P. H., and Wasson J. T. (1976a) Lithophiles, siderophiles, and volatiles in Apollo 16 soils and rocks. *Proc. Lunar Sci. Conf. 7th*, pp. 727-742.
- Boynton W. V., Chou C.-L., Bild R. W., Baedeker P. A., and Wasson J. T. (1976b) Element distribution in size fractions of Apollo-16 soils: evidence for element mobility during regolith processes. *Earth Planet. Sci. Lett.*, 29, 21-33.
- Braddy D., Hutcheon I. D., and Price P. B. (1975) Crystal chemistry of Pu and U and concordant fission track ages of lunar zircons and whitlockites. *Proc. Lunar Sci. Conf. 6th*, pp. 3587-3600.
- Bratt S. R., Solomon S. C., and Head J. W. (1986) The evolution of impact basins: Cooling, subsidence, and thermal stress. *J. Geophys. Res.*, 90, 12415-12433.
- Brett R. (1975a) Thicknesses of some lunar mare basalt flows and ejecta blankets based on chemical kinetic data. *Geochim. Cosmochim. Acta*, 39, 1135-1143.
- Brett R. (1975b) Reduction of mare basalts by sulfur loss (abstract). In *Lunar Science VI*, pp. 89-91. The Lunar Science Institute, Houston.
- Brett R. (1976) Reduction of mare basalts by sulfur loss. *Geochim. Cosmochim. Acta*, 40, 997-1004.
- Brett R., Butler P. Jr., Meyer C. Jr., Reid A. M., Takeda H., and Williams R. (1971) Apollo 12 igneous rocks 12004, 12008, 12009, 12022, a mineralogical and petrological study. *Proc. Lunar Sci. Conf. 2nd*, pp. 301-317.
- Brett R., Gooley R. C., Dowty E., Prinz M., and Keil K. (1973) Oxide minerals in lithic fragments from Luna 20 fines. *Geochim. Cosmochim. Acta*, 37, 761-773.
- Briggs G. A. (1986) What good is a new Moon? Foreword to *Lunar Geoscience Working Group, Status and Future of Lunar Geoscience*. NASA SP-484. 54 pp.
- Brown G. M., Emeleus C. H., Holland J. G., and Phillips R. (1970) Mineralogical, chemical and petrological features of Apollo 11 rocks and their relationship to igneous processes. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 195-219.
- Brown G. M., Emeleus C. H., Holland J. G., Peckett A., and Phillips R. (1971) Picrite basalts, ferrobasalts, feldspathic norites, and rhyolites in a strongly fractionated lunar crust. *Proc. Lunar Sci. Conf. 2nd*, pp. 583-600.
- Brown G. M., Emeleus C. H., Holland J. G., Peckett A., and Phillips R. (1972) Mineral-chemical variations in Apollo

- 14 and Apollo 15 basalts and granitic fractions. *Proc. Lunar. Sci. Conf. 3rd*, pp. 141–157.
- Brown G. M., Peckett A., Phillips R., and Emeleus C. H. (1973) Mineral-chemical variations in the Apollo 16 magnesianfeldspathic rocks. *Proc. Lunar Sci. Conf. 4th*, pp. 505–518.
- Brown G. M., Peckett A., Emeleus C. H., and Phillips R. (1974) Mineral-chemical properties of Apollo-17 mare basalts and terra fragments (abstract). In *Lunar Science V*, pp. 89–91. The Lunar Science Institute, Houston.
- Brown W. E. Jr. (1967) Lunar surface Surveyor radar response. *J. Geophys. Res.*, 72, 791–799.
- Brown W. E. Jr. (1972) Lunar subsurface exploration using coherent radar. In *Lunar Geophysics* (Z. Kopal and D. W. Strangway, eds.), pp. 243–257. Reidel, Dordrecht. (Reprinted in *The Moon*, 4, 113–127.)
- Brown W. E. Jr., Dibos R. A., Gibson G. B., Muhleman D. O., Peake W. H., and Peohls V. J. (1967) Lunar surface electrical properties. In *Surveyor III, a Preliminary Report*, p. 139. NASA SP-146.
- Brown W. E. Jr., Adams G. F., Eggleton R. E., Jackson P., Jordan R., Kobrick M., Peeples W. J., Phillips R. J., Porcello L. J., Schaber G., Sill W. R., Thompson T. W., Ward S. H., and Zelenka J. S. (1974) Elevation profiles of the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 3037–3048.
- Brunfelt A. O., Heier K. S., and Steinnes E. (1971) Determination of 40 elements in Apollo 12 materials by neutron activation analysis. *Proc. Lunar Sci. Conf. 2nd*, pp. 1281–1290.
- Brunfelt A. O., Heier K. S., Nilssen B., Steinnes E., and Sundvoll B. (1972a) Elemental composition of Apollo 15 samples (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 195–197. The Lunar Science Institute, Houston.
- Brunfelt A. O., Heier K. S., Nilssen B., Sundvoll B., and Steinnes E. (1972b) Distribution of elements between different phases of Apollo 14 rocks and soils. *Proc. Lunar Sci. Conf. 3rd*, pp. 1133–1147.
- Brunfelt A. O., Heier K. S., Nilssen B., Steinnes E., and Sundvoll B. (1973a) Elemental composition of Apollo 15 and 16 rocks, fines and minerals (abstract). In *Lunar Science IV*, pp. 100–102. The Lunar Science Institute, Houston.
- Brunfelt A. O., Heier K. S., Nilssen B., Sundvoll B., and Steinnes E. (1973b) Geochemistry of Apollo 15 and 16 materials. *Proc. Lunar Sci. Conf. 4th*, pp. 1209–1218.
- Brunfelt A. O., Heier K. S., Nilssen B., Steinnes E., and Sundvoll B. (1974a) Elemental composition of Apollo 17 fines (abstract). In *Lunar Science V*, pp. 92–94. The Lunar Science Institute, Houston.
- Brunfelt A. O., Heier K. S., Nilssen B., Steinnes E., and Sundvoll B. (1974b) Elemental composition of Apollo 17 fines and rocks. *Proc. Lunar Sci. Conf. 5th*, pp. 981–990.
- Bryan W. B. (1973) Wrinkle ridges as deformed surface crust on ponded mare lava. *Proc. Lunar Sci. Conf. 4th*, pp. 93–106.
- Burke B. F. (1985) Astronomical interferometry on the Moon. In *Lunar Bases and Space Activities of the 21st Century* (W.W. Mendell, ed.), pp. 281–291. Lunar and Planetary Institute, Houston.
- Burke J. D. (1985) Merits of a lunar polar base location. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 77–84. Lunar and Planetary Institute, Houston.
- Burlingame A. L. (1975) The simulated depth history of dust grains in the lunar regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 2397–2415.
- Burnham C. W. (1971) The crystal structure of pyroxferroite from Mare Tranquillitatis. *Proc. Lunar Sci. Conf. 2nd*, pp. 47–57.
- Burns A. A. (1969) Diffuse component of lunar radar echoes. *J. Geophys. Res.*, 74, 6553–6566.
- Burns J. O. (1985) A Moon-Earth radio interferometer. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 293–300. Lunar and Planetary Institute, Houston.
- Burns J. O. and Mendell W. W., eds. (1988) *Future Astronomical Observatories on the Moon* (proceedings of a workshop held in Houston, Texas, January 10, 1986). NASA CP-2489. 134 pp.
- Burns R. G. (1970a) *Mineralogical Applications of Crystal Field Theory*. Cambridge Univ., London. 224 pp.
- Burns R. G. (1970b) Crystal-field spectra and evidence of cation ordering in olivine minerals. *Am. Mineral.*, 55, 1608–1632.
- Burns R. G. and Vaughan D. J. (1975) Polarized electronic spectra. In *Infrared and Raman Spectroscopy of Lunar and Terrestrial Minerals* (C. Karr, ed.), pp. 39–72. Academic, New York.
- Busche F. D., Prinz M., Keil K., and Bunch T. E. (1972) Spinels and the petrogenesis of some Apollo 12 igneous rocks. *Am. Mineral.*, 57, 1729–1747.
- Bussey H. E. (1979) Microwave dielectric measurements of lunar soil with a coaxial line resonator method. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2175–2182.
- Butin R., Kotra R. K., Gibson E. K. Jr., Nace G. A., and McKay D. S. (1984) Hydrogen abundances in lunar soils (abstract). In *Lunar and Planetary Science XV*, pp. 112–113. Lunar and Planetary Institute, Houston.
- Butler J. C. and King E. A. (1974) Analysis of grain size-frequency distributions of lunar fines. *Proc. Lunar Sci. Conf. 5th*, pp. 829–841.
- Butler J. C., Greene G. M., and King E. A. (1973) Grain size, frequency distribution and modal analysis of Apollo 16 fines. *Proc. Lunar Sci. Conf. 4th*, pp. 267–278.
- Butler P. Jr. (1972) Compositional characteristics of olivines from Apollo 12 samples. *Geochim. Cosmochim. Acta*, 36, 773–785.
- Butler P. Jr. (1978) Recognition of lunar glass droplets produced directly from endogenous liquids: The evidence from S-Zn coatings. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1459–1471.
- Butler P. Jr. and Meyer C. (1976) Sulfur prevails in coatings on glass droplets: Apollo 15 green and brown glasses and Apollo 17 orange and black (devitrified) glasses. *Proc. Lunar Sci. Conf. 7th*, pp. 1561–1581.

- BVSP (Basaltic Volcanism Study Project) (1981) *Basaltic Volcanism on the Terrestrial Planets*. Pergamon, New York. 1286 pp.
- Cadenhead D. A. (1973) Lunar volcanic glass and cinder formation. *Eos Trans. AGU*, 54, 582.
- Cadenhead D. A. and Jones B. R. (1972) The adsorption of atomic hydrogen on 15101,168 (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 272-274. The Lunar Science Institute, Houston.
- Cadenhead D. A. and Stetter J. R. (1975) Specific gravities of lunar materials using helium pycnometry. *Proc. Lunar Sci. Conf. 6th*, pp. 3199-3206.
- Cadenhead D. A., Wagner N. J., Jones B. R., and Stetter J. R. (1972) Some surface characteristics and gas interactions of Apollo 14 fines and fragments. *Proc. Lunar Sci. Conf. 3rd*, pp. 2243-2257.
- Cadenhead D. A., Jones B. R., Buerger W. G., and Stetter J. R. (1973) Solar wind and terrestrial atmosphere effects on lunar sample surface composition. *Proc. Lunar Sci. Conf. 4th*, pp. 2391-2401.
- Cadenhead D. A., Stetter J. R., and Buerger W. G. (1974) Pore structure in lunar samples. *J. Colloid Interface Sci.*, 47, 322-336.
- Cadenhead D. A., Brown M. G., Rice D. K., and Stetter J. R. (1977) Some surface area and porosity characterizations of lunar soils. *Proc. Lunar Sci. Conf. 8th*, pp. 1291-1303.
- Cameron A. G. W. and Ward W. R. (1976) The origin of the Moon (abstract). In *Lunar Science VII*, pp. 120-122. The Lunar Science Institute, Houston.
- Cameron E. N. (1971) Opaque minerals in certain lunar rocks from Apollo 12. *Proc. Lunar Sci. Conf. 2nd*, pp. 193-206.
- Cameron K. L. and Cameron M. (1973) Mineralogy of ultramafic nodules from Knippa Quarry, near Uvalde, Texas (abstract). *Geol. Soc. Am. Abstr. with Progr.*, 5, 566.
- Cameron W. S. (1964) An interpretation of Schröter's Valley and other lunar sinuous rilles. *J. Geophys. Res.*, 69, 2523-2430.
- Cameron W. S. (1974) Manifestations and possible sources of lunar transient phenomena (LTP) (abstract). In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), p. 41. The Lunar Science Institute, Houston.
- Cameron W. S. (1978) *Lunar Transient Phenomena Catalog*. NSSDC/WDC-A-R&S 78-03, NASA Goddard Spaceflight Center, Greenbelt, Maryland.
- Cameron W. S., Mantel E. J., and Miller E. R. (1977) *Catalog of Lunar Mission Data*. NSSDC-77-02, National Space Science Data Center, Washington, DC. 204 pp.
- Campbell C. S. and Brennen C. E. (1985) Chute flows of granular materials; some computer simulations. *J. Appl. Mech.*, 52, 172-178.
- Campbell H. W., Hess P. C., and Rutherford M. J. (1978) Ilmenite crystallization in non-mare basalts (abstract). In *Lunar and Planetary Science IX*, pp. 149-151. Lunar and Planetary Institute, Houston.
- Campbell M. J. and Ulrichs J. (1969) Electrical properties of rocks and their significance for lunar radar observations. *J. Geophys. Res.*, 74, 5867-5881.
- Carlson I. C. and Walton W. J. A. Jr. (1978) *Apollo 14 Rock Samples*. Curatorial Facility Publication 14240, NASA Johnson Space Center, Houston. 413 pp.
- Carlson R. W. and Lugmair G. W. (1979) Sm-Nd constraints on early lunar differentiation and the evolution of KREEP. *Earth Planet. Sci. Lett.*, 45, 123-132.
- Carlson R. W. and Lugmair G. W. (1988) The age of ferroan anorthosite 60025: Oldest crust on a young Moon? *Earth Planet. Sci. Lett.*, 90, 119-130.
- Carr M. H. (1966) Geologic map of the Mare Serenitatis region of the moon. *U.S. Geol. Surv. Misc. Geol. Inv. Map I-489*.
- Carr M. H. (1974) The role of lava erosion in the formation of lunar rilles and Martian channels. *Icarus*, 22, 1-23.
- Carrier W. D. III (1970) Lunar soil mechanics on the Apollo missions (abstract). *Texas Civil Engineering* 40, 7.
- Carrier W. D. III (1973) Lunar soil grain size distribution. *The Moon*, 6, 250-263.
- Carrier W. D. III (1974) Apollo drill core relationships. *The Moon*, 10, 183-194.
- Carrier W. D. III (1984) Geotechnical implications for a lunar base (abstract). In *Papers Presented to the 1984 Symposium on Lunar Bases and Space Activities of the 21st Century*, pp. 75-76. NASA, Washington, DC.
- Carrier W. D. III and Heiken G. (1972) *Apollo 14 Lunar Surface Close-up Photography*. NASA TM X-58072. 51 pp.
- Carrier W. D. III, Johnson S. W., Werner R. A., and Schmidt R. (1971) Disturbance in samples recovered with the Apollo core tubes. *Proc. Lunar Sci. Conf. 2nd*, pp. 1959-1972.
- Carrier W. D. III, Johnson S. W., Carrasco L. H., and Schmidt R. (1972a) Core sample depth relationships: Apollo 14 and 15. *Proc. Lunar Sci. Conf. 3rd*, pp. 3213-3221.
- Carrier W. D. III, Bromwell L. G., and Martin R. T. (1972b) Strength and compressibility of returned lunar soil. *Proc. Lunar Sci. Conf. 3rd*, pp. 3223-3234.
- Carrier W. D. III, Mitchell J. K., and Mahmood A. (1973a) The nature of lunar soil. *J. Soil Mech. Found. Div., Am. Soc. Civ. Eng.*, 99, 813-832.
- Carrier W. D. III, Mitchell J. K., and Mahmood A. (1973b) The relative density of lunar soil. *Proc. Lunar Sci. Conf. 4th*, pp. 2403-2411.
- Carrier W. D. III, Bromwell L. G., and Martin R. T. (1973c) Behavior of returned lunar soil in vacuum. *J. Soil. Mech. Found. Div., Am. Soc. Civ. Eng.*, 99, 979-996.
- Carroll W. F. and Blair P. M. (1971) Discoloration and lunar dust contamination of Surveyor III surfaces. *Proc. Lunar Sci. Conf. 2nd*, pp. 2735-2742.
- Carron M. K., Anell C. S., Christian R. P., Cuttitta F., Dwornik E. J., Ligon D. T., and Rose H. J. (1972) Elemental analyses of lunar soil samples from Apollo 15 mission (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 198-201. The Lunar Science Institute, Houston.

- Carter J. L. (1985) Lunar regolith fines: A source of hydrogen. In *Lunar Bases and Space Activities of the 21st Century* (W.W. Mendell, ed.), pp. 571–581. Lunar and Planetary Institute, Houston.
- Carter J. L. and Padovani E. (1973) Genetic implications of some unusual particles in Apollo 16 less than 1 mm fines 68841,11 and 69941,13. *Proc. Lunar Sci. Conf. 4th*, pp. 323–332.
- Carter J. L., Clanton U. S., Fuhrman R., Laughon R. B., McKay D. S., and Usselman T. M. (1975) Morphology and composition of chalcopyrite, chromite, Cu, Ni-Fe, pentlandite, and troilite in vugs of 76015 and 76215. *Proc. Lunar Sci. Conf. 6th*, pp. 719–728.
- Carusi A., Cavaretta G., Cinotti F., Civitti G., Coradini A., Funicello R., Fulchignoni M., and Taddeucci A. (1972) Lunar glasses as an index of the impacted sites lithology: The source area of the Apollo 15 “green glasses.” *Geol. Romana*, 11, 137–151.
- Cashore J. and Woronow A. (1985) A new Monte Carlo model of lunar megaregolith development. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C811–C815.
- Champhess P. E., Dunham A. C., Gibb F. G. F., Giles H. N., MacKenzie W. S., Stumpfl E. F., and Zussman J. (1971) Mineralogy and petrology of some Apollo 12 samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 359–376.
- Chang S., Lennon K., and Gibson E. K. Jr. (1974a) Abundances of C, N, H, He, and S in Apollo 17 soils from stations 3 and 4: Implications for solar wind exposure ages and regolith evolution. *Proc. Lunar Sci. Conf. 5th*, pp. 1785–1800.
- Chang S., Lennon K., and Gibson E. K. Jr. (1974b) Abundances of C, N, H, He, and S in Apollo 17 soils from Stations 3 and 4: Implications for solar wind exposure ages and regolith evolution (abstract). In *Lunar Science V*, pp. 106–108. The Lunar Science Institute, Houston.
- Chao E. C. T. (1973) Geologic implications of the Apollo 14 Fra Mauro breccias and comparison with ejecta from the Ries crater, Germany. *J. Res. U.S. Geol. Surv.*, 1, 1–18.
- Chao E. C. T., Minkin J. A., Frondel C., Klein C. Jr., Drake J. C., Fuchs L., Tani B., Smith J. V., Anderson A. T., Moore P. B., Zechman G. R. Jr., Traill R. J., Plant A. G., Douglas J. A. V., and Dence M. R. (1970) Pyroxferroite, a new calcium-bearing iron silicate from Tranquillity Base. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 65–79.
- Chao E. C. T., Boreman J. A., and Desborough G. A. (1971) Unshocked and shocked Apollo 11 and 12 microbreccias: Characteristics and some geologic implications. *Proc. Lunar Sci. Conf. 2nd*, pp. 797–816.
- Chao E. C. T., Minkin J. A., and Best J. B. (1972a) Apollo 14 breccias: General characteristics and classification. *Proc. Lunar Sci. Conf. 3rd*, pp. 645–659.
- Chao E. C. T., Best J. B., and Minkin J. A. (1972b) Apollo 14 glasses of impact origin and their parent rock types. *Proc. Lunar Sci. Conf. 3rd*, pp. 907–925.
- Charette M. P. and Adams J. B. (1977) Spectral reflectance of lunar highland rocks (abstract). In *Lunar Science VIII*, pp. 172–174. The Lunar Science Institute, Houston.
- Charette M. P., McCord T. B., Pieters C. M., and Adams J. B. (1974) Application of remote spectral reflectance measurements to lunar geology classification and determination of titanium content of lunar soils. *J. Geophys. Res.*, 79, 1605–1613.
- Chen H.-K., Delano J. W., and Lindsley D. H. (1982) Chemistry and phase relations of VLT volcanic glasses from Apollo 14 and Apollo 17. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A171–A181.
- Cherkasov I. I., Vakhnin V. M., Kemurjian A. L., Mikhailov L. N., Mikheyev V. V., Misatov A. A., Smorodinov M. A., and Shvarev V. V. (1968) Determination of the physical and mechanical properties of the lunar surface layer by means of Luna 13 automatic station. In *Moon and Planets II* (A. Dollfus, ed.), pp. 70–76. North-Holland, Amsterdam.
- Chernyak Y. B. (1978) On recent lunar atmosphere. *Nature*, 273, 497–501.
- Cherry M. and Lande K. (1985) A lunar neutrino detector. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 335–343. Lunar and Planetary Institute, Houston.
- Choate R., Batterson S. A., Christensen E. M., Hutton R. E., Jaffe L. D., Jones R. H., Ko H. Y., Scott R. F., Spencer R. L., Sperling F. B., and Sutton G. H. (1968) Lunar surface mechanical properties. In *Surveyor Project. Part 1: Project Description and Performance*, pp. 137–194. JPL Tech. Rpt. 32–1265, Jet Propulsion Laboratory, Pasadena.
- Chou C.-L., Baedeker P. A., and Wasson J. T. (1973) Atmophile elements in lunar soils. *Proc. Lunar Sci. Conf. 4th*, pp. 1523–1533.
- Chou C.-L., Baedeker P. A., Bild R. W., and Wasson J. T. (1974) Volatile-element systematics and green glass in Apollo 15 lunar soils. *Proc. Lunar Sci. Conf. 5th*, pp. 1645–1657.
- Chou C.-L., Boynton W. V., Sundberg L. L., and Wasson J. T. (1975) Volatiles on the surface of Apollo 15 green glass and trace-element distributions among Apollo 15 soils. *Proc. Lunar Sci. Conf. 6th*, pp. 1701–1727.
- Christensen E. M., Batterson S. A., Benson H. E., Chandler C. E., Jones R. H., Scott R. F., Shipely E. N., Sperling F. B., and Sutton G. H. (1967) Lunar surface mechanical properties—Surveyor 1. *J. Geophys. Res.*, 72, 801–813.
- Christensen E. M., Batterson S. A., Benson H. E., Choate R., Jaffe L. D., Jones R. H., Ko H. Y., Spencer R. L., Sperling F. B., and Sutton G. H. (1968a) Lunar surface mechanical properties at the landing site of Surveyor III. *J. Geophys. Res.*, 73, 4081–4094.
- Christensen E. M., Batterson S. A., Benson H. E., Choate R., Hutton R. E., Jaffe L. D., Jones R. H., Ko H. Y., Schmidt F. N., Scott R. F., Spencer R. L., Sperling F. B., and Sutton G. H. (1968b) Lunar surface mechanical properties. In *Surveyor VI, A Preliminary Report*, pp. 41–95. NASA SP-166.
- Christian R. P., Berman S., Dwornik E. J., Rose H. J., and Schnepfe M. M. (1976) Composition of some Apollo 14, 15, and 16 lunar breccias and two Apollo 15 fines (abstract). In *Lunar Science VII*, pp. 138–140. The Lunar Science Institute, Houston.

- Chung D. H. (1972) Laboratory studies on seismic and electrical properties of the Moon. *The Moon*, 4, 356–372.
- Chung D. H. and Westphal W. B. (1973) Dielectric spectra of Apollo 15 and 16 lunar solid samples. *Proc. Lunar Sci. Conf. 4th*, pp. 3077–3091.
- Chung D. H., Westphal W. B., and Simmons G. (1970) Dielectric properties of Apollo 11 lunar samples and their comparison with earth materials. *J. Geophys. Res.*, 75, 6524–6531.
- Chung D. H., Westphal W. B., and Simmons G. (1971) Dielectric behavior of lunar samples: electromagnetic probing of the lunar interior. *Proc. Lunar Sci. Conf. 2nd*, pp. 2381–2390.
- Chung D. H., Westphal W. B., and Olhoeft G. R. (1972) Dielectric properties of Apollo 14 lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 3161–3172.
- Chupp E. L. (1988) High-energy particle production in solar flares (SEP, gamma-ray and neutron emissions). *Physica Scripta*, T18, 5–19.
- Cimbalnikova A., Palivcova M., Frana J., and Mastalka A. (1977) Chemical composition of crystalline rock fragments from Luna 16 and Luna 20 fines. In *The Soviet-American Conference on Cosmochemistry of the Moon and Planets* (J. H. Pomeroy and N. J. Hubbard, eds.), pp. 263–275. NASA SP-370, NASA, Washington, DC.
- Cintala M. J., Wood C. A., and Head J. W. (1977) The effects of target characteristics on fresh crater morphology: Preliminary results for the Moon and Mercury. *Proc. Lunar Sci. Conf. 8th*, pp. 3409–3425.
- Cintala M. J., Garvin J. B., and Wetzel S. J. (1982) The distribution of blocks around a fresh mare crater (abstract). In *Lunar and Planetary Science XIII*, pp. 100–101. Lunar and Planetary Institute, Houston.
- Cirlin E. H. and Housley R. M. (1977) A flameless atomic absorption study of the volatile trace metal lead in lunar samples. *Proc. Lunar Sci. Conf. 8th*, pp. 3931–3940.
- Cirlin E. H. and Housley R. M. (1978) Studies of volatiles in Apollo 17 samples and their implication to vapor transport processes. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2049–2063.
- Cirlin E. H. and Housley R. M. (1979) Scanning Auger microprobe and atomic absorption studies of lunar volcanic volatiles. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 341–354.
- Cirlin E. H. and Housley R. M. (1981) Distribution and evolution of Zn, Cd, and Pb in Apollo 16 regolith samples and the average U-Pb ages of the parent rocks. *Proc. Lunar Planet. Sci. 12B*, pp. 529–540.
- Cirlin E. H., Housley R. M., and Grant R. W. (1978) Studies of volatiles in Apollo 17 samples and their implications to vapor transport processes. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2049–2063.
- Clanton U. S., McKay D. S., Laughon R. B., and Ladle G. H. (1973) Iron crystals in lunar breccias. *Proc. Lunar Sci. Conf. 4th*, pp. 925–931.
- Clanton U. S., McKay D. S., Waits G., and Fuhrman R. (1978) Sublimate morphology on 74001 and 74002 orange and black glassy droplets. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1945–1957.
- Clark P. E. and Adler I. (1978) Utilization of independent solar flux measurements to eliminate non-geochemical variation in X-ray fluorescence data. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3029–3036.
- Clark P. E. and Hawke B. R. (1981) Compositional variation in the Hadley Apennine region. *Proc. Lunar Planet. Sci. 12B*, pp. 727–749.
- Clarke A. C. (1951) *The Exploration of Space*. Harper and Bros., New York. 199 pp.
- Clayton D. D. (1968) *Principles of Stellar Evolution and Nucleosynthesis*. McGraw-Hill, New York. 612 pp.
- Clayton R. N. and Thiemens M. H. (1980) Lunar nitrogen: Evidence for secular change in the solar wind. *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 463–473. Pergamon, New York.
- Clayton R. N., Hurd J. M., and Mayeda T. K. (1972) Oxygen isotopic compositions and oxygen concentrations of Apollo 14 and Apollo 15 rocks and soils. *Proc. Lunar Sci. Conf. 3rd*, pp. 1455–1463.
- Clayton R. N., Mayeda T. K., and Hurd J. M. (1974) Loss of oxygen, silicon, sulfur, and potassium from the lunar regolith. *Proc. Lunar Sci. Conf. 5th*, pp. 1801–1809.
- Coleman P. J., Schubert G., Russell C. T., and Sharp L. R. (1972) Satellite measurements of the Moon's magnetic field: A preliminary report. *The Moon*, 4, 419–429.
- Collins M. (1974) *Carrying the Fire*. Ballantine, New York. 488 pp.
- Colson R. O. and Haskin L. A. (1990) Lunar oxygen and metal for use in near-Earth space: Magma electrolysis. In *Engineering Construction, and Operations in Space II: Proceedings of Space 90* (S. W. Johnson and J. P. Wetzel, eds.), pp. 187–196. American Society of Civil Engineers, New York.
- Comer R. P., Solomon S. C., and Head J. W. (1979) Elastic lithosphere thickness on the Moon from mare tectonic features: A formal inversion. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2441–2463.
- Compston W., Chappell B. W., Amiens P. A., and Vernon M. J. (1970) The chemistry and age of Apollo 11 material. *Proc. Apollo 11 Lunar Sci. Conf*, pp. 1007–1027.
- Compston W., Berry H., Vernon M. J., Chappell B. W., and Kaye M. J. (1971) Rubidium-strontium chronology and chemistry of lunar material from the Ocean of Storms. *Proc. Lunar Sci. Conf. 2nd*, pp. 1471–1485.
- Compston W., Vernon M. J., Berry H., Rudowski R., Gray C. M., Ware N., Chappell B. W., and Kaye M. (1972a) Age and petrogenesis of Apollo 14 basalts (abstract). In *Lunar Science III*, pp. 151–156. The Lunar Science Institute, Houston.
- Compston W., Vernon M. J., Berry H., Rudowski R., Gray C. M., and Ware N. (1972b) Apollo 14 mineral ages and the thermal history of the Fra Mauro Formation. *Proc. Lunar Sci. Conf. 3rd*, pp. 1487–1503.
- Compston W., Vernon M. J., Chappell B. W., and Freeman R. (1973) Rb-Sr model ages and chemical composition

- of nine Apollo 16 soils (abstract). In *Lunar Science IV*, pp. 158–158b. The Lunar Science Institute, Houston.
- Compston W., Foster J. J., and Gray C. M. (1975) Rb-Sr ages of clasts within Boulder 1, Station 2, Apollo 17. *The Moon*, 14, 445–462.
- Compston W., Foster J. J., and Gray C. M. (1977) Rb-Sr systematics in clasts and aphanites from consortium breccia 73215. *Proc. Lunar Sci. Conf. 8th*, pp. 2525–2549.
- Compston W., Williams I. S., and Meyer C. Jr. (1984a) Age and chemistry of zircon from late-stage lunar differentiates (abstract). In *Lunar and Planetary Science XI*, pp. 182–183. Lunar and Planetary Institute, Houston.
- Compston W., Williams I. S., and Meyer C. (1984b) U-Pb geochronology of zircons from lunar breccia 73217 using a sensitive high mass-resolution ion microprobe. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 89, B525–B534.
- Cooper H. S. F. Jr. (1969) *Apollo on the Moon*. Dial, New York. 144 pp.
- Cooper H. S. F. Jr. (1970) *Moon Rocks*. Dial, New York. 197 pp.
- Cooper M. R., Kovach R. L., and Watkins J. S. (1974) Lunar near-surface structure. *Rev. Geophys. Space Phys.*, 12, 291–308.
- Costes N. C. (1973) Regional variations in physical and chemical properties of lunar surface regolith (abstract). In *Lunar Science IV*, pp. 159–161. The Lunar Science Institute, Houston.
- Costes N. C. and Mitchell J. K. (1970) Apollo 11 soil mechanics investigation. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 2025–2044.
- Costes N. C., Carrier W. D. III, Mitchell J. K., and Scott R. F. (1969) Apollo 11 soil mechanics investigation. In *Apollo 11 Preliminary Science Report*, pp. 85–122. NASA SP-214.
- Costes N. C., Carrier W. D. III, Mitchell J. K., and Scott R. F. (1970a) Apollo 11: Soil mechanics results. *J. Soil Mech. Found. Div., Am. Soc. Civ. Eng.*, 96, 2045–2080.
- Costes N. C., Carrier W. D. III, Mitchell J. K., and Scott R. F. (1970b) Apollo 11 soil mechanics investigation. *Science*, 167, 739–741.
- Costes N. C., Cohron G. T., and Moss D. C. (1971) Cone penetration resistance test—An approach to evaluating the in-place strength and packing characteristics of lunar soils. *Proc. Lunar Sci. Conf. 2nd*, pp. 1973–1987.
- Costes N. C., Farmer J. E., and George E. B. (1972) *Mobility Performance of the Lunar Roving Vehicle: Terrestrial Studies Apollo 15 Results*. NASA TR-R-401. 87 pp.
- Cour-Palais B. G. (1974) The current micrometeoroid flux at the Moon for masses $\leq 10^{-7}$ g from the Apollo window and Surveyor 3 TV camera results. *Proc. Lunar Sci. Conf. 5th*, pp. 2451–2462.
- Crawford M. L. (1973) Crystallization of plagioclase in mare basalts. *Proc. Lunar Sci. Conf. 4th*, pp. 705–717.
- Crawford M. L. and Hollister L. S. (1974) KREEP basalt: A possible partial melt from the lunar interior. *Proc. Lunar Sci. Conf. 5th*, pp. 399–419.
- Cremers C. J. (1972) Thermal conductivity of Apollo 14 fines. *Proc. Lunar Sci. Conf. 3rd*, pp. 2611–2617.
- Cremers C. J. and Birkebak R. C. (1971) Thermal conductivity of fines from Apollo 12. *Proc. Lunar Sci. Conf. 2nd*, pp. 2311–2315.
- Cremers C. J. and Hsia H. S. (1973) Thermal conductivity of Apollo 15 fines at low density (abstract). In *Lunar Science IV*, pp. 164–166. The Lunar Science Institute, Houston.
- Cremers C. J., Birkebak R. C., and Dawson J. P. (1970) Thermal conductivity of fines from Apollo 11. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 2045–2050.
- Cripe J. D. and Moore C. B. (1974) Total sulfur contents of Apollo 15 and Apollo 16 lunar samples (abstract). In *Lunar Science V*, pp. 523–525. The Lunar Science Institute, Houston.
- Cripe J. D. and Moore C. B. (1975) Total sulfur contents of Apollo 15, 16 and 17 samples (abstract). In *Lunar Science VI*, pp. 167–168. The Lunar Science Institute, Houston.
- Cripe J. D. and Moore C. B. (1976) Extralunar sulfur in Apollo 16 and 17 lunar fines. *Proc. Lunar Sci. Conf. 7th*, pp. 469–479.
- Criswell D. R. (1972) Lunar dust motion. *Proc. Lunar Sci. Conf. 3rd*, pp. 2671–2680.
- Criswell D. R. (1973) Horizon-low and the motion of lunar dust. In *Photon and Particle Interactions with Surfaces in Space* (R. J. L. Gard, ed.), pp. 545–556. Reidel, Dordrecht.
- Criswell D. R. (1974) Sunset intensification of lunar surface electric fields (abstract). In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), pp. 100–102. The Lunar Science Institute, Houston.
- Criswell D. R. and De B. R. (1977) Intense localized photoelectric charging in the lunar sunset terminator region II. Supercharging at the progression of sunset. *J. Geophys. Res.*, 82, 1005–1007.
- Croft S. K. (1978) Lunar crater volume: Interpretation by models of impact cratering and upper crustal structure. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3711–3733.
- Croft S. K. (1980) Cratering flow field: Implications for the excavation and transient expansion stages of crater formation. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 2347–2378.
- Croft S. K. (1981) The excavation stage of basin formation: a qualitative model. In *Multi-Ring Basins, Proc. Lunar Planet. Sci. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 207–225. Pergamon, New York.
- Crouch D. S. (1971) *Apollo 15 Lunar Surface Drill. Mission Performance and Post-Flight Analysis*. ALSD Proj. Doc. No. MCR-71-318, 30 Oct. 1971, prepared for NASA MSC under Contract No. NAS9-9462 by Martin Marietta Denver Division.
- Crozaz G. (1980) Solar flare and galactic cosmic ray tracks in lunar samples and meteorites: What they tell us about the ancient sun. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 331–346. Pergamon, New York.
- Crozaz G. and Plachy A. L. (1976) Origin of the Apollo 17 deep drill coarse-grained layer. *Proc. Lunar Sci. Conf. 7th*, pp. 123–131.

- Crozaz G. and Ross L. M. (1979) Deposition and irradiation of the Apollo 17 deep drill core. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1229-1241.
- Crozaz G., Haack U., Hair M., Maurette M., Walker R., and Woolum D. (1970) Nuclear track studies of ancient solar radiations and dynamic lunar surface processes. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 2051-2080.
- Crozaz G., Walker R. M., and Woolum D. S. (1971) Nuclear track studies of dynamic surface processes on the Moon and the constancy of solar activity. *Proc. Lunar Sci. Conf. 2nd*, pp. 2543-2558.
- Crozaz G., Drozd R., Hohenberg C., Morgan C., Ralston C., Walker R., and Yuhas D. (1974) Lunar surface dynamics: Some general conclusions and new results from Apollo 16 and 17. *Proc. Lunar Sci. Conf. 5th*, pp. 2475-2499.
- Curran D. R., Shockey D. A., Seaman L., and Austin M. (1977) Mechanisms and models of cratering in Earth media. In *Impact Explosion and Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 1057-1087. Pergamon, New York.
- Curtis D. B. and Wasserburg G. J. (1977) Stratigraphic processes in the lunar regolith—additional insight from neutron fluence measurements on bulk soils and lithic fragments from the deep drill cores. *Proc. Lunar Sci. Conf. 8th*, pp. 3575-3593.
- Cutler A. H. and Krag P. (1985) A carbothermal scheme for lunar oxygen production. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 559-569. Lunar and Planetary Institute, Houston.
- Cuttitta F., Rose H. J., Annell C. S., Canon M. K., Christian R. P., Dwornik E. J., Greenland L. P., Helz A. W., and Ligon D. T. (1971) Elemental composition of some Apollo 12 lunar rocks and soils. *Proc. Lunar Sci. Conf. 2nd*, pp. 1217-1229.
- Cuttitta F., Rose H. J. Jr., Annell C. S., Canon M. K., Christia R. P., Ligon D. T. Jr., Dwornik E. J., Wright T. L., and Greenland L. P. (1973) Chemistry of twenty-one igneous rocks and soils returned by the Apollo 15 mission. *Proc. Lunar Sci. Conf. 4th*, pp. 1081-1096.
- Dalton C. and Hoffman E. (1972) *Conceptual Design of a Lunar Colony*. NASA Grant Rpt. NGT 44-005-1 14, Washington, DC. 505 pp.
- Dalton J., Hollister L. S., Kulick C. G., and Hargraves R. B. (1974) The nature of the chromite to ulvöspinel transition in mare basalt 15555 (abstract). In *Lunar Science V*, pp. 160-162. The Lunar Science Institute, Houston.
- Daniels F. B. (1961) A theory of radar return from the Moon and planets. *J. Geophys. Res.*, 66, 1781-1788.
- Darwin G. (1879) On the procession of a viscous spheroid and on the remote history of the Earth. *Philos. Trans. R. Soc. London*, 170, 447-538.
- Davies R. D. and Gardner F. F. (1966) Linear polarization of the Moon at 6, 11, and 21 cm wavelengths. *Aust. J. Phys.*, 19, 823-836.
- Davis J. R. and Rohlfs D. C. (1964) Lunar radio-reflection properties at decimeter wavelengths. *J. Geophys. Res.*, 69, 3257-3262.
- Davis P. A. (1980) Iron and titanium distribution on the Moon from orbital gamma ray spectrometry with implications for crustal evolutionary models. *J. Geophys. Res.*, 85, 3209-3224.
- Davis P. A. and Spudis P. D. (1985) Petrologic province map of the lunar highlands derived from orbital geochemical data. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 90, D61-D74.
- Davis P. A. and Spudis P. D. (1987) Global petrologic variations on the Moon: A ternary-diagram approach. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E387-E395.
- De B. R. and Criswell D. R. (1977) Intense localized photoelectric charging in the lunar sunset terminator region I. Development of potentials and fields. *J. Geophys. Res.*, 82, 999-1004.
- Debrunner H., Flückiger E., Lockwood J. A., and McGuire R.E. (1984) Comparison of the solar cosmic ray events on May 7, 1978, and November 22, 1977. *J. Geophys. Res.*, 89, 769-774.
- Deer W. A., Howie R. A., and Zussman J. (1978) *Rock-Forming Minerals. Vol. 2A: Single-Chain Silicates*. Wiley, New York. 668 pp.
- DeHon R. A. (1974) Thickness of mare material in the Tranquillitatis and Nectaris basins. *Proc. Lunar Sci. Conf. 5th*, pp. 53-59.
- DeHon R. A. (1979) Thickness of the western mare basalts. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2935-2955.
- DeHon R. A. and Waskom J. D. (1976) Geologic structure of the eastern mare basins. *Proc. Lunar Sci. Conf. 7th*, pp. 2729-2746.
- Delano J. (1975) Petrology of the Apollo 16 mare component: Mare Nectaris. *Proc. Lunar Sci. Conf. 6th*, pp. 15-47.
- Delano J. W. (1979) Apollo 15 green glass: Chemistry and possible origin. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 275-300.
- Delano J. (1980) Chemistry and liquidus phase relations of Apollo 15 red glass: Implications for the deep lunar interior. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 251-288.
- Delano J. (1986) Pristine lunar glasses: Criteria, data, and implications. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D201-D213.
- Delano J. W. and Ringwood A. E. (1978) Siderophile elements in the lunar highlands: Nature of the indigenous component and implications for the origin of the Moon. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 111-159.
- Delano J. W., Bence A. E., Papike J. J., and Cameron K. L. (1973) Petrology of the 2-4 mm soil fraction from the Descartes region of the Moon and stratigraphic implications. *Proc. Lunar Sci. Conf. 4th*, pp. 537-552.
- Delano J. W., Hughes S. S., and Schmitt R. A. (1986) Collaborative study of the Apollo 15 pristine yellow/brown glasses: An interim report (abstract). In *Lunar and Planetary Science XVII*, pp. 172-173. Lunar and Planetary Institute, Houston.
- Dence M. R. (1973) Dimensional analysis of impact structures (abstract). *Meteoritics*, 8, 343-344.

- Dence M. R., Douglas J. A. V., Plant A. G., and Traill R. J. (1970) Petrology, mineralogy and deformation of Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 315–340.
- Dence M. R., Douglas J. A. V., Plant A. G., and Traill R. J. (1971) Mineralogy and petrology of some Apollo 12 samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 285–299.
- Dence M. R., Grieve R. A. F., and Robertson P. B. (1977) Terrestrial impact structures: Principal characteristics and energy considerations. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 247–275. Pergamon, New York.
- DesMarais D. J. (1978) Carbon, nitrogen, and sulfur in Apollo 15, 16, and 17 rocks. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2451–2467.
- DesMarais D. J., Hayes J. M., and Meinschein W. G. (1973) The distribution in lunar soil of carbon released by pyrolysis. *Proc. Lunar Sci. Conf. 4th*, pp. 1543–1558.
- DesMarais D. J., Hayes J. M., and Meinschein W. G. (1974) The distribution in lunar soil of hydrogen released by pyrolysis. *Proc. Lunar Sci. Conf. 5th*, pp. 1811–1822.
- DesMarais D. J., Basu A., Hayes J. M., and Meinschein W. G. (1975) Evolution of carbon isotopes, agglutinates, and the lunar regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 2353–2373.
- Deutsch A. and Stöffler D. (1987) Rb-Sr analyses of Apollo 16 melt rocks and a new age estimate for the Imbrium basin: Lunar basin chronology and the early heavy bombardment of the Moon. *Geochim. Cosmochim. Acta*, 51, 1951–1964.
- Devine J. M., McKay D. S., and Papike J. J. (1982) Lunar regolith: Petrology of the <10 mm fraction. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A260–A268.
- DeWitt J. M. Jr. and Stodola E. K. (1949) Detection of radio signals reflected from the Moon. *Proc. Inst. Radio Eng.*, 37, pp. 229–242.
- Dickinson J. E. and Hess P. C. (1983) Role of whitlockite and apatite in lunar feldspar (abstract). In *Lunar and Planetary Science XIV*, pp. 158–159. Lunar and Planetary Institute, Houston.
- Dickinson T., Taylor G. J., Keil K., Schmitt R. A., Hughes S. S., and Smith M. R. (1985) Apollo 14 aluminous mare basalts and their possible relationship to KREEP. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C365–C374.
- Dietz R. S. (1964) Sudbury structure as an astrobleme. *J. Geol.*, 72, 412–434.
- Ding T. P., Thode H. G., and Rees C. E. (1983) Sulphur content and sulphur isotope composition of orange and black glasses in Apollo 17 drive tube 74002/1. *Geochim. Cosmochim. Acta*, 47, 491–496.
- Dixon J. R. and Papike J. J. (1975) Petrology of anorthosites from the Descartes region of the Moon: Apollo 16. *Proc. Lunar Sci. Conf. 6th*, pp. 263–291.
- Dodd R. T. Jr. (1981) *Meteorites: A Petrologic-Chemical Synthesis*. Cambridge Univ., Cambridge. 368 pp.
- Doe B. R. and Tatsumoto M. (1972) Volatilized lead from Apollo 12 and 14 soils. *Proc. Lunar Sci. Conf. 3rd*, pp. 1981–1988.
- Dolginov Sh. Sh., Yeroshenko Ye. G., Sharova V. A., Vnuchkova T. A., Vanyan L. L., Okulesky B. A., and Bazilevsky A. T. (1976) Study of magnetic field, rock magnetization and lunar electrical conductivity in the Bay Le Monnier. *The Moon*, 15, 3–14.
- Dollfus A. (1961) Polarization studies of the planets. In *The Solar System, Vol. III Planets and Satellites* (G. Kuiper and B. Middlehurst, eds.), pp. 343–399. Univ. of Chicago, Chicago.
- Dollfus A. and Bowell E. (1971) Polarimetric properties of the lunar surface and its interpretation. Part I. Telescopic observations. *Astron. Astrophys.*, 10, 29–53.
- Dollfus A., Geake J. E., and Titulaer C. (1971) Polarimetric properties of the lunar surface and its interpretation. Part 3: Apollo 11 and Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 2285–2300.
- Donaldson C. H., Usselman T. M., Williams R. J., and Lofgren G. E. (1975) Experimental modeling of the cooling history of Apollo 12 olivine basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 843–869.
- Dorman J., Evans S., Nakamura Y., and Latham G. (1978) On the time-varying properties of the lunar seismic meteoroid population. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3615–3626.
- Douchowskoy E. A., Motovilov I. A., Silin A. A., Smorodinov M. I., and Shvarev V. V. (1974) The investigation of the frictional properties of lunar soil and its analogues. In *Lunar Soil from Sea of Fertility*, pp. 582–586. Nauka, Moscow (in Russian).
- Douchowskoy E. A., Markatchev V. V., Silin A. A., Cherkasov I. I., and Shvarev V. V. (1979) The investigation of mechanical properties of Luna 20 soil with the TOR-1 installation. In *Regolith from the Highland Region of the Moon*, pp. 633–634. Nauka, Moscow (in Russian).
- Downs G. S., Goldstein R. M., Green R. R., and Morris G. A. (1971) Mars radar observations, a preliminary report. *Science*, 174, 1324–1327.
- Dowty E., Prinz M., and Keil K. (1973) Composition, mineralogy, and petrology of 28 mare basalts from Apollo 15 rake samples. *Proc. Lunar Sci. Conf. 4th*, pp. 423–444.
- Dowty E., Keil K., and Prinz M. (1974a) Lunar pyroxene-phryic basalts: Crystallization under supercooled conditions. *J. Petrol.*, 15, 419–453.
- Dowty E., Prinz M., and Keil K. (1974b) Ferroan anorthosite: a widespread and distinctive lunar rock type. *Earth Planet. Sci. Lett.*, 24, 15–25.
- Dowty E., Prinz M., and Keil K. (1974c) “Very high alumina basalt”: A mixture and not a magma type. *Science*, 183, 1214–1215.
- Dowty E., Keil K., Prinz M., Gros J., and Takahashi H. (1976) Meteorite-free Apollo 15 crystalline KREEP. *Proc. Lunar Sci. Conf. 7th*, pp. 1833–1844.
- Drake M. J., McCallum I. S., McKay G. A., and Weill D. F. (1970) Mineralogy and petrology of Apollo 12 sample no. 12013. A progress report. *Earth Planet. Sci. Lett.*, 9, 103–123.

- Dran J. C., Durrieu L., Jouret C., and Maurette M. (1970) Habit and texture studies of lunar and meteoritic materials with a 1 MeV electron microscope. *Earth Planet. Sci. Lett.*, 9, 391–400.
- Drozd R. J., Hohenberg C. M., Morgan C. J., and Ralston C. E. (1974) Cosmic-ray exposure history at the Apollo 16 and at other lunar sites: Lunar surface dynamics. *Geochim. Cosmochim. Acta*, 38, 1625–1642.
- Drozd R. J., Hohenberg C. M., Morgan C. J., Podosek F. A., and Wroge M. L. (1977) Cosmic-ray exposure history of Taurus-Littrow. *Proc. Lunar Sci. Conf. 8th*, pp. 3027–3043.
- Duba A., Heard H. C., and Schock R. N. (1976) Electrical conductivity of orthopyroxene to 1400°C and the resulting selenotherm. *Proc. Lunar Sci. Conf. 7th*, pp. 3173–3181.
- Duba A., Dennison M., Irving A. J., Thornber C. R., and Huebner J. S. (1979) Electrical conductivity of aluminous orthopyroxene (abstract). In *Lunar and Planetary Science X*, pp. 318–319. Lunar and Planetary Institute, Houston.
- Duke J. M. (1976) The distribution of the period four transition elements among olivine, calcic pyroxene, and mafic silicate liquid: Experimental results. *J. Petrol.*, 17, 499–521.
- Duke M. B. and Nagle J. S. (1974) *Lunar Core Catalog*. NASA JSC Publication JSC-09252. NASA Johnson Space Center, Houston.
- Duke M. B., Woo C. C., Bird M. L., Sellers G. A., and Finkelman R. B. (1970a) Lunar soil: Size distribution and mineralogical constituents. *Science*, 167, 648–650.
- Duke M. B., Woo C. C., Sellers G. A., Bird M. L., and Finkelman R. B. (1970b) Genesis of lunar soil at Tranquility Base. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 347–361.
- Duke M. B., Mendell W. W., and Roberts B. B. (1985) Strategies for a permanent lunar base. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 57–68. Lunar and Planetary Institute, Houston.
- Duncan A. R., Erlank A. J., Willis J. P., and Ahrens L. H. (1973) Composition and interrelationships of some Apollo 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1097–1113.
- Duncan A. R., Erlank A. J., Willis J. P., Sher M. K., and Ahrens L. H. (1974) Trace element evidence for a two-stage origin of some titaniferous mare basalts. *Proc. Lunar Sci. Conf. 5th*, pp. 1147–1157.
- Duncan A. R., Sher M. K., Abraham Y. C., Erlank A. J., Willis J. P., and Ahrens L. H. (1975) Interpretation of the compositional variability of Apollo 15 soils. *Proc. Lunar Sci. Conf. 6th*, pp. 2309–2320.
- Duraud J. P., Langevin Y., Maurette M., Comstock G. M., and Burlingame A. L. (1975) The simulated depth history of dust grains in the lunar regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 2397–2415.
- Durgunoglu H. T. and Mitchell J. K. (1975) Static penetration resistance of soils: I—Analysis. *Proc. Specialty Conf. on In Situ Measurement of Soil Properties*, pp. 151–171. American Society of Civil Engineers, Raleigh.
- Dyal P. and Daily W. D. (1979) Electrical conductivity anomalies associated with circular lunar maria. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2291–2297.
- Dyal P. and Parkin G. W. (1971) The Apollo 12 magnetometer experiment, internal lunar properties from transient and steady magnetic field measurements. *Proc. Lunar Sci. Conf. 2nd*, pp. 2391–2413.
- Dyal P., Parkin C. W., and Daily W. D. (1974) Magnetism and the interior of the Moon. *Rev. Geophys. Space Phys.*, 12, 568–591.
- Dyal P., Parkin C. W., and Daily W. D. (1976) Structure of the lunar interior from magnetic field measurements. *Proc. Lunar Sci. Conf. 7th*, pp. 3077–3095.
- Dymek R. F., Albee A. L., and Chodos A. A. (1975a) Comparative petrology of lunar cumulate rocks of possible primary origin: Dunite 72415, troctolite 76535, norite 78235, and anorthosite 62237. *Proc. Lunar Sci. Conf. 6th*, pp. 301–341.
- Dymek R. F., Albee A. L., and Chodos A. A. (1975b) Comparative mineralogy and petrology of Apollo 17 mare basalts: Samples 70215, 71055, 74255, and 75055. *Proc. Lunar Sci. Conf. 6th*, pp. 49–77.
- Dymek R. F., Albee A. L., and Chodos A. A. (1976) Petrology and origin of Boulders #2 and #3, Apollo 17 Station 2. *Proc. Lunar Sci. Conf. 7th*, pp. 2335–2378.
- Eberhardt P., Geiss J., Graf H., Grögler N., Krähenbühl U., Schwaller H., Schwarzmüller J., and Stettler A. (1970) Trapped solar wind noble gases, exposure age and K/Ar-age in Apollo 11 lunar fine material. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1037–1070.
- Eberhardt P., Geiss J., Graf H., Grögler N., Mendia M. D., Mörgelli M., Schwaller H., Stettler A., Krähenbühl U., and von Gunten H. R. (1972) Trapped solar wind noble gases in Apollo 12 lunar fines 12001 and Apollo 11 breccia 10046. *Proc. Lunar Sci. Conf. 3rd*, pp. 1821–1856.
- Eberhardt P., Geiss J., Grögler N., Mauer P., and Stettler A. (1973) ³⁹Ar–⁴⁰Ar ages of lunar material (abstract). *Meteoritics*, 8, 360–361.
- Eggleton R. E. and Schaber G. E. (1972) Cayley formation interpreted as basin ejecta. In *Apollo 16 Preliminary Science Report*, pp. 29–7 to 29–17. NASA SP-315.
- Ehmann W. D. and Chyi L. L. (1974) Abundances of the group IVB elements, Ti, Zr, and Hf and implications of their ratios in lunar materials. *Proc. Lunar Sci. Conf. 5th*, pp. 1015–1024.
- Ehrlich R. and Weinberg B. (1970) An exact method for characterization of grain shape. *J. Sed. Petrol.*, 40, 205–212.
- Eisentraut K. J., Black M. S., Hileman F. D., Sievers R. E., and Ross W. D. (1972) Beryllium and chromium abundances in Fra Mauro and Hadley-Apennine lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1327–1333.
- Elachi C., Koblrick M., Roth L., Tiernan M., and Brown W. E. Jr. (1976) Local lunar topography from the Apollo 17 ALSE radar imagery and altimetry. *The Moon*, 15, 119–131.
- Elachi C., Roth L. E., and Schaber G. G. (1984) Spaceborne radar subsurface imaging in hyperarid regions. *IEEE Trans. Geosci. and Rem. Sens.*, GE-22, pp. 383–388.

- El-Baz F. (1972) The Alhazen to Abul Wafa swirl belt: An extensive field of light-colored, sinuous marking. In *Apollo 16 Preliminary Science Report*, pp. 29–93 to 29–97. NASA SP-315.
- El Goresy A. and Ramdohr P. (1975) Subsolidus reduction of lunar opaque oxides: Textures, assemblages, geochemistry, and evidence for a late-stage endogenic gaseous mixture. *Proc. Lunar Sci. Conf. 6th*, pp. 729–745.
- El Goresy A. and Ramdohr P. (1977) Apollo 17 TiO₂-rich basalts: Reverse spinel zoning as evidence for subsolidus equilibration of the spinel-ilmenite assemblage. *Proc. Lunar Sci. Conf. 8th*, pp. 1611–1624.
- El Goresy A., Ramdohr P., and Taylor L. A. (1971a) The geochemistry of the opaque minerals in Apollo 14 crystalline rocks. *Earth Planet. Sci. Lett.*, 13, 121–129.
- El Goresy A., Ramdohr P., and Taylor L. A. (1971b) The opaque minerals in the lunar rocks from Oceanus Procellarum. *Proc. Lunar Sci. Conf. 2nd*, pp. 219–235.
- El Goresy A., Taylor L. A., and Ramdohr P. (1972) Fra Mauro crystalline rocks: Mineralogy, geochemistry, and subsolidus reduction of opaque minerals. *Proc. Lunar Sci. Conf. 3rd*, pp. 333–349.
- El Goresy A., Ramdohr P. and Medenbach O. (1973a) Lunar samples from Descartes site: Opaque mineralogy and geochemistry. *Proc. Lunar Sci. Conf. 4th*, pp. 733–750.
- El Goresy A., Ramdohr P., Pavicevic M., Medenbach O., Müller O., and Gentner W. (1973b) Zinc, lead, chlorine, and FeOOH-bearing assemblages in the Apollo 16 sample 66095: Origin by impact of a comet or a carbonaceous chondrite. *Earth Planet. Sci. Lett.*, 18, 411–419.
- El Goresy A., Prinz M., and Ramdohr P. (1976) Zoning in spinels as an indicator of the crystallization histories of mare basalts. *Proc. Lunar Sci. Conf. 7th*, pp. 1261–1279.
- Engel A. E. J. and Engel C. G. (1970a) Lunar rock compositions and some interpretations. *Science*, 167, 527–528.
- Engel A. E. J. and Engel C. G. (1970b) Lunar rock compositions and some interpretations. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1081–1084.
- Engelhardt W., Hurrle H., and Luft E. (1976) Microimpact-induced changes of textural parameters and modal composition of the lunar regolith. *Proc. Lunar Sci. Conf. 7th*, pp. 373–392.
- England A. W. (1975) Thermal microwave emission from a scattering layer. *J. Geophys. Res.*, 80, 4484–4496.
- Epstein S. and Taylor H. P. Jr. (1970) The concentration and isotopic composition of hydrogen, carbon, and silicon in Apollo 11 lunar rocks and minerals. *Proc. Apollo 11 Sci. Conf.*, pp. 1085–1096.
- Epstein S. and Taylor H. P. Jr. (1971) O¹⁸/O¹⁶, Si³⁰/Si²⁸, D/H, and C¹³/C¹² ratios in lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1421–1441.
- Epstein S. and Taylor H. P. Jr. (1972) O¹⁸/O¹⁶, Si³⁰/Si²⁸, C¹³/C¹², and D/H studies of Apollo 14 and 15 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1429–1454.
- Epstein S. and Taylor H. P. Jr. (1973) The isotopic composition and concentration of water, hydrogen, and carbon in some Apollo 15 and 16 soils and in the Apollo 17 orange soil. *Proc. Lunar Sci. Conf. 4th*, pp. 1559–1575.
- Epstein S. and Taylor H. P. Jr. (1974) D/H and ¹⁸O/¹⁶O ratios of H₂O in the “rusty” breccia 66095 and the origin of “lunar water.” *Proc. Lunar Sci. Conf. 5th*, pp. 1839–1854.
- Epstein S. and Taylor H. P. Jr. (1975) Investigation of the carbon, hydrogen, oxygen, and silicon isotope and concentration relationships on the grain surfaces of a variety of lunar soils and in some Apollo 15 and 16 core samples. *Proc. Lunar Sci. Conf. 6th*, pp. 1771–1798.
- Erickson J. E. (1969) Analysis of the meteoroid flux measured by Explorer 16 and Lunar Orbiter. *Astron. J.*, 74, 279–283.
- Eugster O. (1986) Noble gases in grain size fractions of lunar anorthosite 60018: Trapped xenon isotopically similar to terrestrial atmospheric xenon (abstract). In *Lunar and Planetary Science XVII*, pp. 212–213. Lunar and Planetary Institute, Houston.
- Eugster O. and Niedermann S. (1987) Trapped Xe isotopically different from modern solar wind Xe in lunar breccia 60018 and black glass 74001 (abstract). In *Lunar and Planetary Science XVIII*, pp. 275–276. Lunar and Planetary Institute, Houston.
- Eugster O., Eberhardt P., Geiss J., Grögler N., Jungck M., and Mörgeli M. (1975) Solar-wind-trapped and cosmic-ray-produced noble gases in Luna 20 soil. *Proc. Lunar Sci. Conf. 6th*, pp. 1989–2007.
- Eugster O., Grögler N., Eberhardt P., and Geiss J. (1980) Double drive tube 74001/2: Composition of noble gases trapped 3.7 AE ago. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1565–1592.
- Evans J. V. (1957) The scattering of radio waves by the Moon. *Proc. Phys. Soc. London*, B70, 1112.
- Evans J. V. (1962) Radio echo studies of the Moon. In *Physics and Astronomy of the Moon* (Z. Kopal, ed.), pp. 429–480. Academic, New York.
- Evans J. V. (1969) Radar studies of planetary surfaces. *Annu. Rev. Astron. Astrophys.*, 7, 201–248.
- Evans J. V. and Hagfors T. (1964) On the interpretation of radar reflections from the Moon. *Icarus*, 3, 151–160.
- Evans J. V. and Hagfors T. (1966) Study of radio echoes from the Moon at 23 centimeters wavelength. *J. Geophys. Res.*, 71, 4871–4889.
- Evans J. V. and Pettengill G. H. (1963) The scattering behavior of the Moon at wavelengths of 3, 6, 68 and 785 centimeters. *J. Geophys. Res.*, 68, 423–447.
- Evans J. V., Evans S., and Thompson J. H. (1959) The rapid fading of Moon echoes at 100 Mc/s. In *Paris Symposium on Radio Astronomy* (R. N. Bracewell, ed.), pp. 8–12. Stanford Univ., Stanford, California.
- Evensen N. M., Hamilton P. J., and O’Nions R. K. (1978) Rare-earth abundances in chondritic meteorites. *Geochim. Cosmochim. Acta*, 42, 1199–1212.
- Fagin S. W., Worrall D. M., and Muehlberger W. R. (1978) Lunar ridge orientations: Implications for lunar tectonic models. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3473–3479.
- Fechtig H., Hartung J. B., Nagel K., Neukum G., and Storzer D. (1974) Lunar microcrater studies, derived meteoroid

- fluxes, and comparison with satellite-borne experiments. *Proc. Lunar Sci. Conf. 5th*, pp. 2463-2474.
- Fedorets V. A. (1952) Photographic photometry of the lunar surface. *Publ. Astron. Obs. of the Kharkov State University*, 2, 49-109 (in Russian).
- Feldman W. C., Ashbridge J. R., Bame S. J., and Gosling J. T. (1977) Plasma and magnetic fields from the Sun. In *The Solar Output and its Variation* (O. R. White, ed.), pp. 351-382. Colorado Assoc. Univ., Boulder.
- Fenner M. A., Freeman J. W. Jr., and Hills H. K. (1973) The electric potential of the lunar surface. *Proc. Lunar Sci. Conf. 4th*, pp. 2877-2887.
- Ferrari A. J., Nelson D. L., Sjogren W. L., and Phillips R. J. (1978) The isostatic state of the lunar Apennines and regional surroundings. *J. Geophys. Res.*, 83, 2863-2871.
- Filleux C., Spear R. H., Tombrello T. A., and Burnett D. S. (1978) Direct measurement of surface carbon concentrations for lunar soil breccias. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1599-1617.
- Finkelman R. B., Baedeker P. A., Christian R. P., Berman S., Schneppe M. M., and Rose H. J. Jr. (1975) Trace-element chemistry and reducing capacity of size fractions from the Apollo 16 regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 1385-1398.
- Fireman E. L. (1980) Solar activity during the past 10⁴ years from radionuclides in lunar samples. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 267-278. Pergamon, New York.
- Firsoff V. A. (1961) *Moon Atlas*. Hutchinson, London. 128 pp.
- Fisher A. D. (1977) A model for microwave intensity propagation in an inhomogeneous medium. *IEEE Trans. Antennas Propag.*, AP-25, 876-882.
- Fisher A. D. and Staelin D. H. (1977) Possible effect of subsurface inhomogeneities on the lunar microwave spectrum. *Icarus*, 32, 98-105.
- Fleischer R. L. and Hart H. R. Jr. (1974) Uniformity of the uranium content of lunar green and orange glasses. *Proc. Lunar Sci. Conf. 5th*, pp. 2251-2255.
- Fleischer R. L., Hart H. R. Jr., and Giard W. R. (1974) Surface history of lunar soil and soil columns. *Geochim. Cosmochim. Acta*, 38, 365-380.
- Fleischer R. L., Price P. B., and Walker R. M. (1975) *Nuclear Tracks in Solids: Principles and Applications*. Univ. of California, Berkeley. 605 pp.
- Floran R. B., Grieve R. A. F., Phinney W. C., Warner J. L., and Simonds C. H. (1978) Manicouagan impact melt, Quebec, 1, stratigraphy, petrology and chemistry. *J. Geophys. Res.*, 83, 2737-2760.
- Florensky C. P., Basilevsky A. T., Ivanov A. V., Pronin A. A., and Rode O. D. (1977) Luna 24: Geologic setting of landing site and characteristics of sample core (preliminary data). *Proc. Lunar Sci. Conf. 8th*, pp. 3257-3279.
- Florensky C. P., Basilevsky A. T., Bobina N. N., Burba G. A., Grebennik N. N., Kuzmin R. O., Polosukhin B. P., Popovich V. D., Pronin A. A., and Ronca L. B. (1978) The floor of crater Le Monier: A study of Lunokhod 2 data. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1449-1458.
- Florensky P. V. (1975) The Zhamanschin meteorite crater (the Northern Near-Aral) and its tektites and impactites. *Academy of Sciences of the USSR, Geological Serial*, 10, 74-86.
- Folk R. L. (1968) *Petrology of Sedimentary Rocks*. Hemphill's, Austin. 170 pp.
- Folk R. L. and Ward W. C. (1957) Brazos River bar: A study in the significance of grain size parameters. *J. Sed. Petrol.*, 27, 3-26.
- Fouche K. F. and Smales A. A. (1967) The distribution of trace elements in chondritic meteorites. 2. Antimony, arsenic, gold, palladium and rhenium. *Chem. Geol.* 2, 105-134.
- Freeman J. W. and Ibrahim M. E. (1974) The lunar electric potential and its plasma sheath effects (abstract). In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), pp. 86-88. The Lunar Science Institute, Houston.
- Freeman J. W. Jr., Hills H. K., and Vondrak R. R. (1972) Water vapor, whence comest thou? *Proc. Lunar Sci. Conf. 3rd*, pp. 2217-2230.
- French B. M. and Short N. M., eds. (1968) *Shock Metamorphism of Natural Materials*. Mono, Baltimore. 644 pp.
- Frick U., Baur H., Funk H., Phinney D., Schafer C., Schultz L., and Signer P. (1973) Diffusion properties of light noble gases in lunar fines. *Proc. Lunar Sci. Conf. 4th*, pp. 1987-2002.
- Fricke S. J., Ingalls R. P., Mason J. C., Stone M. L., and Swift D. W. (1960) Computation and measurement of the fading rate of Moon-reflected UHF signals. *J. Res. Natl. Bur. Stand.*, 64D, 455-465.
- Friedman I., O'Neil J. R., Gleason J. D., and Hardcastle K. (1971) The carbon and hydrogen content and isotopic composition of some Apollo 12 materials. *Proc. Lunar Sci. Conf. 2nd*, pp. 1407-1415.
- Friel J. J. and Goldstein J. I. (1976) An experimental study of phosphate reduction and phosphorus-bearing lunar metal particles. *Proc. Lunar Sci. Conf. 7th*, pp. 791-806.
- Friel J. J. and Goldstein J. I. (1977) The relationship between lunar metal particles and phosphate minerals. *Proc. Lunar Sci. Conf. 8th*, pp. 3955-3965.
- Friel J. J., Harkey R. I., and Ulmer G. C. (1977) Armalcolite stability as a function of pressure and oxygen fugacity. *Geochim. Cosmochim. Acta*, 41, 403-410.
- Frisillo A. L., Olhoeft G. R., and Strangway D. W. (1975) Effects of pressure, temperature and density on the electrical properties of lunar samples 72441,12, 15301,38 and a terrestrial basalt. *Earth Planet. Sci. Lett.*, 24, 345-356.
- Frondel C., Klein C. J., and Ito J. (1971) Mineralogical and chemical data on Apollo 12 lunar fines. *Proc. Lunar Sci. Conf. 2nd*, pp. 719-726.
- Frondel J. W. (1975) *Lunar Mineralogy*. Wiley, New York. 323 pp.
- Fruchter J. S., Robyn M. A., and Goles G. G. (1974a) Compositional affinities of clasts and matrix from breccia 66055 (abstract). In *Lunar Science V*, pp. 251-253. The Lunar Science Institute, Houston.

- Fruchter J. S., Kridelbaugh S. J., Robyn M. A., and Goles G. G. (1974b) Breccia 66055 and related clastic materials from the Descartes region, Apollo 16. *Proc. Lunar Sci. Conf. 5th*, pp. 1035–1046.
- Fruiland R. M. (1983) *Regolith Breccia Workbook*. NASA Planetary Materials Branch Publ. No. 66, NASA Johnson Space Center, Houston. 260 pp.
- Fruiland R. M., Morris R. V., McKay D. S., and Clanton U. S. (1977) Apollo 17 roapy glasses. *Proc. Lunar Sci. Conf. 8th*, pp. 3095–3111.
- Fryxell R. and Heiken G. (1974) Preservation of lunar core samples: Preparation and interpretation of three-dimensional stratigraphic sections. *Proc. Lunar Sci. Conf. 5th*, pp. 935–966.
- Fuchs L. H. (1969) The phosphate mineralogy of meteorites. In *Meteorite Research* (P. M. Millman, ed.), pp. 683–695. Reidel, Dordrecht.
- Fuchs L. H. (1970) Fluorapatite and other accessory minerals in Apollo 11 rocks. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 475–479.
- Fujiwara A., Kamimoto G., and Tsukamoto A. (1977) Destruction of basaltic bodies by high velocity impact. *Icarus*, 31, 277–288.
- Fukuoka T., Laul J. C., Smith M. R., Hughes S. S., and Schmitt R. A. (1986) Chemistry of Yamato-791197 Antarctic meteorite: Evidence for its lunar highland origin. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 84–95. Natl. Inst. for Polar Res., Tokyo.
- Fuller E. L., Holmes H. F., Gammage R. B., and Becker K. (1971) Interaction of gases with lunar materials: Preliminary results. *Proc. Lunar Sci. Conf. 2nd*, pp. 2009–2019.
- Fuller M. (1974) Lunar magnetism. *Rev. Geophys. Space Phys.*, 12, 23–64.
- Fung A. K. (1982) A review of volume scatter theories for modeling applications. *Radio Sci.*, 17, 1007–1017.
- Fung A. K. and Moore R. K. (1964) Effects of structure size on moon and earth radar returns of various angles. *J. Geophys. Res.*, 69, 1075–1081.
- Funkhouser J. G., Schaffer O. A., Bogard D. D., and Zahringer J. (1970) Gas analysis of the lunar surface. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1111–1116.
- Gaddis L. R., Pieters C. M., and Hawke B. R. (1985) Remote sensing of lunar pyroclastic mantling deposits. *Icarus*, 61, 461–489.
- Gammage R. B. and Holmes H. F. (1975) Specific surface area as a maturity index of lunar fines. *Earth Planet. Sci. Lett.*, 27, 424–426.
- Gammage R. B. and Holmes H. F. (1977) Effect of annealing temperature on the reactivity of lunar fines towards adsorbed water. *Earth Planet. Sci. Lett.*, 34, 445–449.
- Ganapathy R. and Anders E. (1974) Bulk compositions of the Moon and Earth, estimated from meteorites. *Proc. Lunar Sci. Conf. 5th*, pp. 1181–1206.
- Ganapathy R., Keays R. R., Laul J. C., and Anders E. (1970) Trace elements in Apollo 11 lunar rocks: Implications for meteorite influx and origin of Moon. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1117–1142.
- Ganapathy R., Morgan J. W., Krähenbühl U., and Anders E. (1973) Ancient meteoritic components in lunar highlands rocks: Clues from trace elements in Apollo 15 and 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1239–1261.
- Ganapathy R., Morgan J. W., Higuchi H., and Anders E. (1974) Meteoritic and volatile elements in Apollo 16 rocks and in separated phases from 14306. *Proc. Lunar Sci. Conf. 5th*, pp. 1659–1683.
- Gancarz A. J., Albee A. L., and Chodos A. A. (1971) Petrologic and mineralogic investigations of some crystalline rocks returned by the Apollo 14 mission. *Earth Planet. Sci. Lett.*, 12, 1–18.
- Gancarz A. J., Albee A. L., and Chodos A. A. (1972) Comparative petrology of Apollo 16 sample 68415 and Apollo 14 samples 14276 and 14310. *Earth Planet. Sci. Lett.*, 16, 307–330.
- Gangadharan S., Sankar-Das M., and Yegnasubramanian S. (1974) Elemental analyses of Luna 16 and 20 regolith samples. In *Further Advances in Lunar Research: Luna 16 and 20 Samples* (N. Bhandari and M. N. Rao, eds.), pp. 47–52. Indian Natl. Sci. Acad., New Delhi.
- Garg A. N. and Ehmann W. N. (1976) Zr-Hf fractionation in chemically defined lunar rock types. *Proc. Lunar Sci. Conf. 7th*, pp. 3397–3410.
- Garshnek V. (1989) Crucial factor: Human. Safely extending the human presence in space. *Space Policy*, August, 201–216.
- Gary B., Stacey J., and Drake F. D. (1965) Radiometric mapping of the Moon at 3 millimeters wavelength. *Astrophys. J. Suppl.* 108, 12, 239–262.
- Gary B. L. and Keihm S. J. (1978) Interpretation of ground-based microwave measurements of the Moon using a detailed regolith properties model. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2885–2900.
- Gast P. W. (1968) Trace element fractionation and the origin of tholeiitic and alkaline magma types. *Geochim. Cosmochim. Acta*, 32, 1057.
- Gatehouse B. M., Grey I. E., Lovering J. F., and Wark D. A. (1977) Structural studies on tranquillityite and related synthetic phases. *Proc. Lunar Sci. Conf. 8th*, pp. 1831–1838.
- Gault D. E. (1970) Saturation and equilibrium conditions for impact cratering on the lunar surface: Criteria and implications. *Radio Sci.*, 5, 273–291.
- Gault D. E. (1973) Displaced mass, depth, diameter and effects of oblique trajectories for impact craters formed in dense crystalline rocks. *The Moon*, 4, 32–44.
- Gault D. E. and Greeley R. (1978) Exploratory experiments of impact craters formed in viscous-liquid targets: Analogs for martian rampart craters? *Icarus*, 34, 486–495.
- Gault D. E. and Sonett C. P. (1982) Laboratory simulation of pelagic asteroidal impact: Atmospheric injection, benthic topography, and the surface wave radiation field. In *Geological Implications of Impacts of Large Asteroids and Comets on the Earth* (L. T. Silver and P. H. Schultz, eds.), pp. 69–92. Geol. Soc. Am. Spec. Pap. 190.

- Gault D. E. and Wedekind J. A. (1969) The destruction of tektites by micrometeoroid impact. *J. Geophys. Res.*, 74, 6780–6794.
- Gault D. E., Quaide W. L., and Oberbeck V. R. (1968) Impact cratering mechanics and structures. In *Shock Metamorphism of Natural Materials* (B. M. French and N. M. Short, eds.), pp. 87–99. Mono, Baltimore.
- Gault D. E., Hörz F., Hartung J. B., and Brownlee D. E. (1974) Mixing of the lunar regolith. *Proc. Lunar Sci. Conf. 5th*, pp. 2365–2386.
- Gay P., Bown M. G., and Muir I. D. (1972) Mineralogical and petrographic features of two Apollo 14 rocks. *Proc. Lunar Sci. Conf. 3rd*, pp. 351–362.
- Gehrels T., ed. (1979) *Asteroids*. Univ. of Arizona, Tucson. 1181 pp.
- Gehrels T., Coffeen T., and Owings D. (1964) Wavelength dependence of polarization. III. The lunar surface. *Astron. J.*, 69, 826–852.
- Geiss J. (1973) Solar wind composition and implications about the history of the solar system. In *Papers Presented to the 13th Int. Cosmic Ray Conf.*, 5, pp. 3375–3398. Univ. of Denver, Denver, Colorado.
- Gerstenkorn H. (1955) Über Gezeitenreibung beim Zweikörper-problem. *Zeit. Astrophys.*, 36, 245–274.
- Gibb F. G. F., Stumpfl E. F., and Zussman J. (1970) Opaque minerals in an Apollo 12 rock. *Earth Planet. Sci. Lett.*, 9, 217–224.
- Gibbons R. V., Morris R. V., and Hörz F. (1975) Petrographic and ferromagnetic resonance studies of experimentally shocked regolith analogues. *Proc. Lunar Sci. Conf. 6th*, pp. 3143–3171.
- Gibbons R. V., Hörz F., and Schaal R. B. (1976) The chemistry of some individual lunar soil agglutinates. *Proc. Lunar Sci. Conf. 7th*, pp. 405–422.
- Gibson E. K. Jr. (1973) Thermal analysis—Mass spectrometer computer system and its application to the evolved gas analysis of Green River shale and lunar soil samples. *Thermochim. Acta*, 5, 243–255.
- Gibson E. K. Jr. (1977) Volatile elements, carbon, nitrogen, sulfur, sodium, potassium, and rubidium in the lunar regolith. *Phys. Chem. Earth*, 10, 57–62.
- Gibson E. K. Jr. and Andrawes F. F. (1978a) Sulfur abundances in the 74001/74002 drive tube from Shorty Crater, Apollo 17. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2011–2017.
- Gibson E. K. Jr. and Andrawes F. F. (1978b) Nature of the gases released from lunar rocks and soils upon crushing. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2433–2450.
- Gibson E. K. Jr. and Bustin R. (1987) Hydrogen abundances vs. depth in the lunar regolith: results from an Apollo double drive tube and deep drill core (abstract). In *Lunar and Planetary Science XVIII*, pp. 324–325. Lunar and Planetary Institute, Houston.
- Gibson E. K. Jr. and Moore G. W. (1973a) Carbon and sulfur distributions and abundances in lunar fines. *Proc. Lunar Sci. Conf. 4th*, pp. 1577–1586.
- Gibson E. K. Jr. and Moore C. B. (1973b) Volatile-rich lunar soil: Evidence of possible cometary impact. *Science*, 179, 69–71.
- Gibson E. K. Jr. and Moore G. W. (1973c) Variable carbon contents of lunar soil 74220. *Earth Planet. Sci. Lett.*, 20, 404–408.
- Gibson E. K. Jr. and Moore G. W. (1974) Sulfur abundances and distributions in the valley of Taurus-Littrow. *Proc. Lunar Sci. Conf. 5th*, pp. 1823–1837.
- Gibson E. K. Jr., Chang S., Lennon K., Moore G. W., and Pearce G. W. (1975) Sulfur abundances and distributions in mare basalts and their source magmas. *Proc. Lunar Sci. Conf. 6th*, pp. 1287–1301.
- Gibson E. K. Jr., Usselman T. M., and Morris R. V. (1976) Sulfur in Apollo 17 basalts and their source regions. *Proc. Lunar Sci. Conf. 7th*, pp. 1491–1505.
- Gibson E. K. Jr., Brett R., and Andrawes F. (1977) Sulfur in lunar mare basalts as a function of bulk composition. *Proc. Lunar Sci. Conf. 8th*, pp. 1417–1428.
- Gibson E. K. Jr., Bustin R., Skaugset A., Can R. H., Wentworth S. J., and McKay D. S. (1987) Hydrogen distributions in lunar materials (abstract). In *Lunar and Planetary Science XVIII*, pp. 326–327. Lunar and Planetary Institute, Houston.
- Gibson M. A. and Knudsen C. W. (1985) Lunar oxygen production from ilmenite. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 543–550. Lunar and Planetary Institute, Houston.
- Gifford A. W. and El-Baz F. (1978) Thickness of mare flow units (abstract). In *Lunar and Planetary Science IX*, pp. 382–384. Lunar and Planetary Institute, Houston.
- Gifford A. W. and El-Baz F. (1981) Thicknesses of lunar mare flow fronts. *Moon and Planets*, 24, 391–398.
- Gillum D. E., Ehmann W. D., Wakita H., and Schmitt R. A. (1972) Bulk and rare earth abundances in the Luna-16 soil levels A and D. *Earth Planet. Sci. Lett.*, 13, 444–449.
- Glasstone S. (1965) *Sourcebook on the Space Sciences*. Van Nostrand, Princeton. 937 pp.
- Goel P. S. and Kothari B. K. (1972) Total nitrogen contents of some Apollo 14 lunar samples by neutron activation analysis. *Proc. Lunar Sci. Conf. 3rd*, pp. 2041–2050.
- Goel P. S., Shukla P. N., Kothari B. K., and Garg A. N. (1975) Total nitrogen in lunar soils, breccias, and rocks. *Geochim. Cosmochim. Acta*, 39, 1347–1352.
- Goins N. R. (1978) Lunar seismology: The internal structure of the Moon. Ph.D. thesis, Massachusetts Institute of Technology, Cambridge, Massachusetts. 666 pp.
- Goins N. R., Toksoz M. N., and Dainty A. M. (1978) Seismic structure of the lunar mantle: An overview. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3575–3588.
- Goins N. R., Dainty A. M., and Toksoz M. N. (1980) Seismic energy release from the Moon (abstract). In *Lunar and Planetary Science XI*, pp. 336–338. Lunar and Planetary Institute, Houston.
- Goins N. R., Dainty A. M., and Toksöz N. F. (1981) Seismic energy release of the Moon. *J. Geophys. Res.*, 86, 378–388.
- Gold T. (1966) The Moon's surface. In *The Nature of the Lunar Surface: Proceedings of the 1965 IAU-NASA*

- Symposium* (W. N. Hess, D. H. Menzel, and J. A. O'Keefe, eds.), pp. 107–124. Johns Hopkins, Baltimore.
- Gold T. (1974) The evidence for a surface transport mechanism on the Moon (abstract). In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), pp. 36–37. The Lunar Science Institute, Houston.
- Gold T. and Williams J. G. (1973) Electrostatic transportation of dust on the Moon. In *Photon and Particle Interactions with Surfaces in Space* (R. L. Grard, ed.), pp. 557–560. Reidel, Dordrecht.
- Gold T. and Williams J. G. (1974) Electrostatic transportation of lunar dust (abstract). In *Lunar Interactions* (D. R. Criswell and J. W. Freeman, eds.), pp. 38–40. The Lunar Science Institute, Houston.
- Gold T., Campbell M. J., and O'Leary B. T. (1970) Optical and high frequency electrical properties of lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 2149–2154.
- Gold T., O'Leary B. T., and Campbell M. (1971) Some physical properties of Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 2173–2181.
- Gold T., Bilson E., and Yerbury M. (1972) Grain size analysis, optical reflectivity measurements and determination of high frequency electrical properties for Apollo 14 lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 3187–3193.
- Gold T., Bilson E., and Yerbury M. (1973) Grain size analysis and high frequency electrical properties of Apollo 15 and 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 3093–3100.
- Gold T., Bilson E., and Baron R. L. (1975) Auger analysis of lunar soil; study of processes which change the surface chemistry and albedo. *Proc. Lunar Sci. Conf. 6th*, pp. 3285–3303.
- Gold T., Bilson E., and Baron R. L. (1976) Electrical properties of Apollo 17 rock and soil samples and a summary of the electrical properties of lunar material at 450 MHz frequency. *Proc. Lunar Sci. Conf. 7th*, pp. 2593–2603.
- Gold T., Bilson E., and Baron R. L. (1977) Electrical properties at 450 MHz of Apollo 15 and 16 deep drill core samples and surface soil samples at the same site. *Proc. Lunar Sci. Conf. 8th*, pp. 1271–1275.
- Goldberg R. H., Burnett D. S., and Tombrello T. A. (1975) Fluorine surface films on lunar samples: Evidence for both lunar and terrestrial origins. *Proc. Lunar Sci. Conf. 6th*, pp. 2189–2200.
- Goldberg R. H., Tombrello T. A., and Burnett D. S. (1976) Fluorine as a constituent in lunar magmatic gases. *Proc. Lunar Sci. Conf. 7th*, pp. 1597–1613.
- Goldstein B. E. (1974) Observations of electrons at the lunar surface. *J. Geophys. Res.*, 79, 23–35.
- Goldstein B. E. (1978) Lunar interaction with the solar wind—effects on lunar electrical conductivity estimates. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3093–3112.
- Goldstein J. I. and Axon H. J. (1973) Composition, structure, and thermal history of metallic particles from 3 Apollo 16 soils, 65701, 68501, and 63501. *Proc. Lunar Sci. Conf. 4th*, pp. 751–775.
- Goldstein J. I. and Blau P. J. (1973) Chemistry and thermal history of metal particles in Luna 20 soils. *Geochim. Cosmochim. Acta*, 37, pp. 847–855.
- Goldstein J. I. and Yakowitz H. (1971) Metallic inclusions and metal particles in the Apollo 12 lunar soil. *Proc. Lunar Sci. Conf. 2nd*, pp. 177–191.
- Goldstein J. I., Axon H. J., and Yen C. F. (1972) Metallic particles in the Apollo 14 lunar soil. *Proc. Lunar Sci. Conf. 3rd*, pp. 1037–1064.
- Goldstein J. I., Hewins R. H., and Axon H. J. (1974) Metal silicate relationships in Apollo 17 soils. *Proc. Lunar Sci. Conf. 5th*, pp. 653–671.
- Goles G. G., Randle K., Osawa M., Schmitt R. A., Wakita H., Ehmann W. D., and Morgan J. W. (1970a) Elemental abundances by instrumental activation analyses in chips from 27 lunar rocks. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1165–1176.
- Goles G. G., Randle K., Osawa M., Lindstrom D. J., Jerome D. Y., Steinborn T. L., Beyer R. L., Martin M. R., and McKay S. M. (1970b) Interpretations and speculations on elemental abundances in lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1177–1194.
- Goles G. G., Duncan A. R., Lindstrom D. J., Martin M. R., Beyer R. L., Osawa M., Randle K., Meek L. T., Steinborn T. L., and McKay S. M. (1971) Analyses of Apollo 12 specimens—compositional variations, differentiation processes, and lunar soil mixing models. *Proc. Lunar Sci. Conf. 2nd*, pp. 1063–1082.
- Golombek M. P. (1979) Structural analysis of lunar grabens and the shallow crustal structure of the Moon. *J. Geophys. Res.*, 84, 4657–4666.
- Goodman R. J. (1972) The distribution of Ga and Rb in coexisting groundmass and phenocryst phases of some basic volcanic rocks. *Geochim. Cosmochim. Acta*, 36, 303–317.
- Goodrich C. A., Taylor G. J., Keil K., Kallemeyn G. W., and Warren P. H. (1986) Alkali norite, troctolites, and VHK mare basalts from breccia 14304. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D305–D318.
- Gooley R. C., Brett R., and Warner J. L. (1973) Crystallization history of metal particles in Apollo 16 rake samples. *Proc. Lunar Sci. Conf. 4th*, pp. 799–810.
- Gooley R., Brett R., and Warner J. L. (1974) A lunar rock of deep crustal origin: Sample 76535. *Geochim. Cosmochim. Acta*, 38, 1329–1339.
- Gorenstein P., Golub L., and Bjorkholm P. (1974) Radon emanation from the Moon, spatial and temporal variability. *The Moon*, 9, 129–140.
- Gorshkov E. S., Gus'kova E. G., and Pochtarev V. I. (1972) Magnetic properties of lunar specimens returned by ALS Luna 16. In *COSPAR Space Research XII*, pp. 83–85. Akademie-Verlag, Berlin.
- Gorshkov E. S., Gus'kova E. G., and Pochtarev V. I. (1973) Magnetic investigations of lunar soil delivered by ALS Luna 16. In *COSPAR Space Research XIII*, pp. 961–964. Akademie-Verlag, Berlin.

- Görz H., White W. E., Roy R., and Johnson G. G. (1971) Particle size and shape distributions of lunar fines by CESEMI. *Proc. Lunar Sci. Conf. 2nd*, pp. 2021–2025.
- Görz H., White E. W., Johnson G. G., and Pearson M. W. (1972) CESEMI studies of Apollo 14 and 15 fines. *Proc. Lunar Sci. Conf. 3rd*, pp. 3195–3200.
- Goswami J. N. and Lal D. (1977) Particle track correlation studies in lunar soils: Possible long-term periodic fluctuations in ancient meteoritic flux at 1 A.U. *Proc. Lunar Sci. Conf. 8th*, pp. 813–824.
- Goswami J. N. and Lal D. (1979) Depositional history of the Apollo 17 deep drill core based on particle track record. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1253–1267.
- Goswami J. N., Lal D., and Macdougall J. D. (1980) Charge composition and energy spectra of ancient solar flare heavy nuclei. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 347–364. Pergamon, New York.
- Goswami J. N., McGuire R. E., Reedy R. C., Lal D., and Jha R. (1988) Solar flare protons and alpha particles during the last three solar cycles. *J. Geophys. Res.*, 93, 7195–7205.
- Graham D. G., Muenow D. W., and Gibson E. K. (1979) Some effects of gas absorption on the high temperature volatile release behavior of a terrestrial basalt, tektite and lunar soil. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1617–1627.
- Grant R. W., Housley R. M., Szalkowski F. J., and Marcus H. L. (1974) Auger electron microscopy of lunar samples. *Proc. Lunar Sci. Conf. 5th*, pp. 2423–2439.
- Greeley R. (1971) Lava tubes and channels in the lunar Marius Hills. *The Moon*, 3, 289–314.
- Greeley R. and Hyde J. H. (1972) Lava tubes of the Cave basalts, Mount St. Helens, Washington. *Geol. Soc. Am. Bull.*, 83, 2397–2418.
- Greeley R. and Spudis P. D. (1986) Hadley Rille, lava tubes and mare volcanism at the Apollo 15 site. In *Workshop on the Geology and Petrology of the Apollo 15 Landing Site* (P. D. Spudis and G. Ryder, eds.), pp. 58–61. LPI Tech. Rpt. 86–03, Lunar and Planetary Institute, Houston.
- Green D. H. and Ringwood A. E. (1973) Significance of a primitive lunar basaltic composition present in Apollo 15 soils and breccias. *Earth Planet. Sci. Lett.*, 19, 1–8.
- Green D. H., Ware N. G., Hibberson W. O., and Major A. (1971) Experimental petrology of Apollo 12 basalts: Part 1, sample 12009. *Earth Planet. Sci. Lett.*, 13, 85–96.
- Green D. H., Ringwood A. E., Ware N. G., and Hibberson W. O. (1972) Experimental petrology and petrogenesis of Apollo 14 basalts. *Proc. Lunar Sci. Conf. 3rd*, pp. 197–206.
- Green D. H., Ringwood A. E., Hibberson W. O., and Ware N. G. (1975) Experimental petrology of Apollo 17 mare basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 871–893.
- Greene G. M., King D. T. Jr., Banholzer G. S. Jr., and King E. A. (1975) Size and modal analyses of fines and ultrafines from some Apollo 17 samples. *Proc. Lunar Sci. Conf. 6th*, pp. 517–528.
- Greenwood W. R., Jones R. L., Heiken G. H., Bender M. J., and Hill R. O. (1971) *Lunar Surface Closeup Stereoscopic Photography on the Sea of Tranquility (Apollo 11 Landing Site)*. NASA TM-X-58077. 23 pp.
- Grieve R. A. F. (1981) Impact cratering. *Nature*, 291, 16.
- Grieve R. A. F. (1982) The record of impact on Earth: Implications for major Cretaceous/Tertiary impact event. In *Geological Implications of Impacts of Large Asteroids and Comets on the Earth* (L. T. Silver and P. H. Schultz), pp. 25–38. Geol. Soc. Am. Spec. Pap. 190.
- Grieve R. A. F. and Garvin J. B. (1984) A geometric model for excavation and modification at terrestrial simple craters. *J. Geophys. Res.*, 89, 11561–11572.
- Grieve R. A. F. and Robertson P. B. (1979) The terrestrial cratering record: I. Current status of observations. *Icarus*, 38, 212–229.
- Grieve R. A. F., Dence M. R., and Robertson P. B. (1977) Cratering processes: As interpreted from the occurrence of impact melts. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 791–814. Pergamon, New York.
- Grieve R. A. F., Robertson P. B., and Dence M. R. (1981) Constraints on the formation of ring impact structures, based on terrestrial data. In *Multi-Ring Basins, Proc. Lunar Planet. Sci. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 37–58. Pergamon, New York.
- Gromov V. V., Leonovich A. K., Lozhkin V. A., Rybakov A. V., Pavlov P. S., Dmitryev A. D., and Shvarev V. V. (1972) Results of investigations of the physical and mechanical properties of the lunar sample from Luna 16. *COSPAR Space Research XII*, pp. 43–52. Akademie-Verlag, Berlin.
- Gromov V. V., Leonovich A. K., Shvarev V. V., Loshkin V. A., Penetrigov V. N., Semenov P. S., Ribakov A. V., Naumov P. N., Grushevsky V. P., and Gubarev V. M. (1979) The results of an investigation of the physical and mechanical properties of lunar soil in nitrogen gas. In *Regolith from the Highland Region of the Moon*, pp. 686–690. Nauka, Moscow (in Russian).
- Gros J., Takahashi H., Hertogen J., Morgan J. W., and Anders E. (1976) Composition of the projectiles that bombarded the lunar highlands. *Proc. Lunar Sci. Conf. 7th*, pp. 2403–2425.
- Grossman J. J., Mukherjee N. R., and Ryan J. A. (1972) Microphysical, microchemical and adhesive properties of lunar material, III. Gas interactions with lunar material. *Proc. Lunar Sci. Conf. 3rd*, pp. 2259–2269.
- Grove T. L. (1978) Cooling histories of Luna 24 very low Ti (VLT) ferrobasalts: An experimental study. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 565–584.
- Grove T. L. (1982) Use of lamellae in lunar clinopyroxenes as cooling rate speedometers: An experimental calibration. *Am. Mineral.*, 67, 251–268.
- Grove T. L. and Beaty D. W. (1980) Classification, experimental petrology and possible volcanic histories of the Apollo 11 high-K basalts. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 149–177.
- Grove T. L. and Bence A. E. (1977) Experimental study of pyroxene-liquid interaction in quartz-normative basalt 15597. *Proc. Lunar Sci. Conf. 8th*, pp. 1549–1579.

- Grove T. L. and Bence A. E. (1979) Crystallization kinetics in a multiply saturated basalt magma: An experimental study of Luna 24 ferrobasalt. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 439–478.
- Grove T. L. and Raudsepp M. (1978) Effects of kinetics on the crystallization of quartz normative basalt 15597: An experimental study. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 585–599.
- Grove T. L. and Vaniman D. T. (1978) Experimental petrology of very low Ti (VLT) basalts. In *Mare Crisium: The View from Luna 24* (J. J. Papike and R. B. Merrill, eds.), pp. 445–472. Pergamon, New York.
- Grove T. L. and Walker D. (1977) Cooling histories of Apollo 15 quartz-normative basalts. *Proc. Lunar Sci. Conf. 8th*, pp. 1501–1520.
- Grove T. L., Walker D., Longhi J., Stolper E., and Hays J. F. (1973) Petrology of rock 12002 and origin of picritic basalts at Oceanus Procellarum. *Proc. Lunar Sci. Conf. 4th*, pp. 995–1011.
- Grün E., Zook H. A., Fechtig H., and Giese R. H. (1985) Collisional balance of the meteoritic complex. *Icarus*, 62, 244–272.
- Guest J. E. and Murray J. B. (1976) Volcanic features of the nearside equatorial lunar maria. *J. Geol. Soc. Lond.*, 132, 251–258.
- Gurtler C. A. and Grew G. W. (1968) Meteoroid hazard near Moon. *Science*, 161, 462–464.
- Gutschewski G. L., Kinsler D. C., and Whitaker E. (1971) *Atlas and Gazetteer of the Near Side of the Moon*. NASA SP-241. 538 pp.
- Habakov A. V. (1949) *Grundlegende Fragen de Entwicklung der Mondoberfläche*. Moscow.
- Hafner S. S., Niebuhr H. H., and Zeira S. (1973) Ferric iron in plagioclase crystals from anorthosite 15415 (abstract). In *Lunar Science IV*, pp. 326–328. The Lunar Science Institute, Houston.
- Hagfors T. (1961) Some properties of radio waves reflected from the Moon and planets. *J. Geophys. Res.*, 66, 777–785.
- Hagfors T. (1964) Backscattering from an undulating surface with applications to radar returns from the Moon. *J. Geophys. Res.*, 69, 3779–3784.
- Hagfors T. (1966) Relationship of geometric optics and autocorrelation approaches to the analysis of lunar and planetary data. *J. Geophys. Res.*, 71, 379–383.
- Hagfors T. (1967) A study of the depolarization of lunar radar echoes. *Radio Sci.*, 2, 445–465.
- Hagfors T. (1968) Relations between rough surfaces and their scattering properties as applied to radar astronomy. In *Radar Astronomy* (J. V. Evans and T. Hagfors, eds.), pp. 187–218. McGraw-Hill, New York.
- Hagfors T. (1970) Remote probing of the Moon by infrared and microwave emissions and by radar. *Radio Sci.*, 5, 189–227.
- Hagfors T. and Campbell D. B. (1973) Mapping of planetary surfaces with radar. *Proc. IEEE*, 61, 1219–1225.
- Hagfors T. and Evans J. V. (1968) Radar studies of the Moon. In *Radar Astronomy* (J. V. Evans and T. Hagfors, eds.), pp. 219–273. McGraw-Hill, New York.
- Hagfors T., Brockelman R. A., Danforth H. H., Hanson L. B., and Hyed G. M. (1965) Tenuous surface layer on the Moon—evidence derived from radar observations. *Science*, 150, 1153–1156.
- Hagfors T., Green J. L., and Guillen A. (1969) Determination of the albedo of the Moon at a wavelength of 6 meters. *Astron. J.*, 74, 1214–1219.
- Haggerty S. E. (1971a) Compositional variations in lunar spinels. *Nature Phys. Sci.*, 233, 156–160.
- Haggerty S. E. (1971b) Subsolidus reduction of lunar spinels. *Nature Phys. Sci.*, 234, 113–117.
- Haggerty S. E. (1972a) Apollo 14 subsolidus reduction and compositional variations of spinels. *Proc. Lunar Sci. Conf. 3rd*, pp. 305–333.
- Haggerty S. E. (1972b) Chemical characteristics of spinels in some Apollo 15 basalts (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 92–97. The Lunar Science Institute, Houston.
- Haggerty S. E. (1972c) Luna 16: An opaque mineral study and a systematic examination of compositional variations of spinels from Mare Fecunditatis. *Earth Planet. Sci. Lett.*, 13, 328–352.
- Haggerty S. E. (1972d) Solid solutions, subsolidus reduction and compositional characteristics of spinels in some Apollo 15 basalts. *Meteoritics*, 7, 353–370.
- Haggerty S. E. (1972e) The mineral chemistry of some decomposition and reaction assemblages associated with Cr-Zr, Ca-Zr, and Fe-Mg-Zr titanites (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 88–91. The Lunar Science Institute, Houston.
- Haggerty S. E. (1973a) Armalcolite and genetically associated opaque minerals in the lunar samples. *Proc. Lunar Sci. Conf. 4th*, pp. 777–797.
- Haggerty S. E. (1973b) Luna 20: Mineral Chemistry of spinel, pleonaste, chromite, ulvöspinel, ilmenite, and rutile. *Geochim. Cosmochim. Acta*, 37, 857–867.
- Haggerty S. E. (1977) Apollo 14: Oxide, metal, and olivine mineral chemistries in 14072 with a bearing on the temporal relationships of subsolidus reduction. *Proc. Lunar Sci. Conf. 8th*, pp. 1809–1829.
- Haggerty S. E. (1978a) Luna 24: Systematics in spinel mineral chemistry in the context of an intrusive petrogenetic grid. In *Mare Crisium: The View From Luna 24*, (R. B. Merrill and J. J. Papike, eds.), pp. 523–536. Pergamon, New York.
- Haggerty S. E. (1978b) The redox state of planetary basalts. *Geophys. Res. Lett.*, 5, 443–446.
- Haggerty S. E., Boyd F. R., Bell P. M., Finger L. W., and Bryan W. B. (1970) Opaque minerals and olivine in lavas and breccias from Mare Tranquillitatus. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 513–538.
- Halajian J. D. (1964) *The Case for a Cohesive Lunar Surface Model*. Grumman Research Dept. Report ADR 04–40–64.2, Grumman Aircraft Engineering Corp., Bethpage, New York.
- Halajian J. D. (1966) *Mechanical, Optical, Thermal, and Electrical Properties of the Surveyor I Landing Site*.

- Grumman Research Dept. Report AS424-4, Grumman Aircraft Engineering Corp., Bethpage, New York.
- Hale W. (1980) Orientations of central peaks in lunar craters: Implications for regional structural trends. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 197-209. Pergamon, New York.
- Hale W. S. and Grieve R. A. F. (1982) Volumetric analysis of complex lunar craters: Implications for basin ring formation. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A65-A76.
- Hale W. S. and Head J. W. (1979) Central peaks in lunar craters: Morphology and morphometry. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2623-2633.
- Hall J. L., Solomon S. C., and Head J. W. (1981) Lunar floor-fractured craters: Evidence for viscous relaxation of crater topography. *J. Geophys. Res.*, 86, 9357-9552.
- Hanan B. B. and Tilton G. R. (1987) 60025: Relict of primitive lunar crust? *Earth Planet. Sci. Lett.*, 84, 15-21.
- Hansen E. C., Smith J. V., and Steele I. M. (1980) Petrology and mineral chemistry of 67667, a unique feldspathic ilherzolite. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 523-533.
- Hansen T. P. (1970) *Guide to Lunar Orbiter Photographs*. NASA SP-242. 125 pp.
- Hapke B. W. (1963) A theoretical photometric function for the lunar surface. *J. Geophys. Res.*, 68, 4571-4586.
- Hapke B. (1981) Bidirectional reflectance spectroscopy: 1. Theory. *J. Geophys. Res.*, 86, 3039-3054.
- Hapke B. (1984) Bidirectional reflectance spectroscopy: 3. Correction for macroscopic roughness. *Icarus*, 59, 41-59.
- Hargraves J. K. (1959) Radio observations of the lunar surface. *Proc. Phys. Soc. London*, 73, 536-537.
- Hargraves R. B. and Hollister L. S. (1972) Mineralogic and petrologic study of lunar anorthosite slide 15415,18. *Science*, 175, 430-432.
- Hartmann W. K. (1966) Early lunar cratering. *Icarus*, 5, 406-418.
- Hartmann W. K. (1972) Paleocratering of the Moon. Review of post-Apollo data. *Astrophys. Space Sci.*, 17, 48-64.
- Hartmann W. K. (1975) Lunar "cataclysm": A misconception. *Icarus*, 24, 181-187.
- Hartmann W. K. (1980) Dropping stones in magma oceans: Effects of early lunar cratering. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 155-171. Pergamon, New York.
- Hartmann W. K. and Davis D. R. (1975) Satellite-sized planetesimals and lunar origin. *Icarus*, 24, 504-515.
- Hartmann W. K. and Kuiper G. P. (1962) Concentric structures surrounding lunar basins. *Commun. Lunar Planet. Lab.*, 1, 51-66.
- Hartmann W. K. and Wood C. A. (1971) Origin and evolution of multi-ring basins. *The Moon*, 3, 2-78.
- Hartmann W. K., Phillips R. J., and Taylor G. J., eds. (1986) *Origin of the Moon*. Lunar and Planetary Institute, Houston. 781 pp.
- Hartung J. B. (1976) Age of 20-km diameter lunar crater: 797 years, 62 ± 2 days (abstract). In *Lunar Science VII*, pp. 348-350. The Lunar Science Institute, Houston.
- Hartung J. B. and Storzer D. (1974) Lunar microcraters and their solar flare track record. *Proc. Lunar Sci. Conf. 5th*, pp. 2527-2541.
- Hartung J. B., Hauser E. E., Hörz F., Morrison D. A., Schonfeld E., Zook H. A., Mandeville J. C., McDonnell J. A. M., Schaal R. B., and Zinner E. (1978) Lunar surface processes: Report of the 12054 consortium. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2507-2537.
- Haselton J. D. and Nash W. P. (1975) A model for the evolution of opaques in mare lavas. *Proc. Lunar Sci. Conf. 6th*, pp. 747-755.
- Haskin L. A. and Korotev R. L. (1977) Test of a model for trace element partition during closed-system solidification of a silicate liquid. *Geochim. Cosmochim. Acta*, 41, 921-939.
- Haskin L. A., Haskin M. A., Frey F. A., and Wildeman T. R. (1968) Relative and absolute abundances of the rare earths. In *Origin and Distribution of the Elements* (L. H. Ahrens, ed.), pp. 889-912. Pergamon, New York.
- Haskin L. A., Allen R. O., Helmke P. A., Paster T. P., Anderson M. A., Korotev R. L., and Zweifel K. A. (1970) Rare earths and other trace elements in Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1213-1231.
- Haskin L. A., Helmke P. A., Allen R. O., Anderson M. R., Korotev R. L., and Zweifel K. A. (1971) Rare-earth elements in Apollo 12 lunar materials. *Proc. Lunar Sci. Conf. 2nd*, pp. 1307-1317.
- Haskin L. A., Helmke P. A., Blanchard D. P., Jacobs J. W., and Telunder K. (1973) Major and trace element abundances in samples from the lunar highlands. *Proc. Lunar Sci. Conf. 4th*, pp. 1275-1296.
- Haskin L. A., Shih C.-Y., Bansal B. M., Rhodes J. M., Wiesman H., and Nyquist L. E. (1974) Chemical evidence for the origin of 76535 as a cumulate. *Proc. Lunar Sci. Conf. 5th*, pp. 1213-1225.
- Haskin L. A., Lindstrom M. M., Salpas P. A., and Lindstrom D. J. (1981) On compositional variations among lunar anorthosites. *Proc. Lunar Planet. Sci. 12B*, pp. 41-66.
- Hawke B. R. and Bell J. F. (1981) Remote sensing studies of lunar dark-halo impact craters: Preliminary results and implications for early volcanism. *Proc. Lunar Planet. Sci. 12B*, pp. 665-678.
- Hawke B. R. and Head J. W. (1977) Pre-Imbrian history of the Fra Mauro region and Apollo 14 sample provenance. *Proc. Lunar Sci. Conf. 8th*, pp. 2741-2761.
- Hawke B. K., MacLaskey D., McCord T. B., Adams J. B., Head J. W., Pieters C. M., and Zisk S. H. (1979) Multispectral imaging of the Apollo 15 Apennine region: The identification and distribution of regional pyroclastic deposits. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2995-3015.
- Haymes R. C. (1985) Lunar based gamma ray astronomy. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 307-314. Lunar and Planetary Institute, Houston.

- Hazen R. M., Mao H. K., and Bell P. M. (1977) Effects of compositional variation on absorption spectra of lunar olivines. *Proc. Lunar Sci. Conf. 8th*, pp. 1081–1090.
- Hazen R. M., Bell P. M., and Mao H. K. (1978) Effects of compositional variation on absorption spectra of lunar pyroxenes. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2919–2934.
- Head J. W. (1974a) Orientale multi-ringed basin interior and implications for the petrogenesis of lunar highland samples. *The Moon*, 11, 327–356.
- Head J. W. (1974b) Stratigraphy of the Descartes Region (Apollo 16): Implications for the origin of samples. *The Moon*, 11, 77–100.
- Head J. W. (1976a) Lunar volcanism in space and time. *Rev. Geophys. Space Phys.*, 14, 265–300.
- Head J. W. (1976b) Evidence for the sedimentary origin of Imbrium sculpture and lunar basin radial texture. *The Moon*, 15, 445–462.
- Head J. W. (1977) Origin of outer rings in lunar multi-ring basins: Evidence from morphology and ring spacing. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 567–573. Pergamon, New York.
- Head J. W. (1979) Serenitatis multi-ringed basin: Regional geology and basin ring interpretation. *Moon and Planets*, 21, 439–462.
- Head J. W. (1982) Lava flooding of ancient planetary crusts: Geometry, thickness, and volumes of flooded lunar impact basins. *Moon and Planets*, 26, 61–88.
- Head J. W. and Gifford A. (1980) Lunar mare domes: Classification and mode of origin. *Moon and Planets*, 22, 235–258.
- Head J. W. and McCord T. B. (1978) Imbrian-age highland volcanism on the Moon: The Gruithuisen and Mairan domes. *Science*, 199, 1433–1436.
- Head J. W. and Wilson L. (1979) Alphonsus type dark-halo craters: Morphology, morphometry and eruption conditions. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2861–2897.
- Head J. W., Settle M., and Stein R. S. (1975) Volume of material ejected from major basins and implications for the depth of excavation of lunar samples. *Proc. Lunar Sci. Conf. 6th*, pp. 2805–2829.
- Head J. W., Adams J. B., McCord T. B., Pieters C., and Zisk S. (1978) Regional stratigraphy and geologic history of Mare Crisium. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 43–74. Pergamon, New York.
- Heiken G. (1975) Petrology of lunar soils. *Rev. Geophys. Space Phys.*, 13, 567–587.
- Heiken G. H. and Carrier W. D. III (1971) *Lunar Surface Closeup Stereoscopic Photography on the Ocean of Storms (Apollo 12 Landing Site)*. NASA TM X-58078. 40 pp.
- Heiken G. and McEwen M. C. (1972) The geologic setting of the Luna 20 site. *Earth Planet. Sci. Lett.*, 17, 3–6.
- Heiken G. and McKay D. S. (1974) Petrography of Apollo 17 soils. *Proc. Lunar Sci. Conf. 5th*, pp. 843–860.
- Heiken G. and McKay D. S. (1977) A model for eruption behavior of a volcanic vent in eastern Mare Serenitatis. *Proc. Lunar Sci. Conf. 8th*, pp. 3243–3255.
- Heiken G. H. and McKay D. S. (1978) Petrology of a sequence of pyroclastic rocks from the valley of Taurus-Littrow (Apollo 17 landing site). *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1933–1943.
- Heiken G. H., McKay D. S., and Fruland R. M. (1973) Apollo 16 soils: Grain size analysis and petrography. *Proc. Lunar Sci. Conf. 4th*, pp. 251–265.
- Heiken G. H., McKay D. S., and Brown R. W. (1974) Lunar deposits of possible pyroclastic origin. *Geochim. Cosmochim. Acta*, 38, 1703–1718.
- Heiken G. H., Morris R. V., McKay D. S., and Fruland R. M. (1976) Petrographic and ferromagnetic resonance studies of the Apollo 15 deep drill core. *Proc. Lunar Sci. Conf. 7th*, pp. 93–111.
- Heinzen C. R. and Peer W. F. (1971) *Lunar Surface Resolution: Coverage of Lunar Orbiter Photography*. JPL Publication 760–63, Jet Propulsion Laboratory, Pasadena. 5 pp.
- Helmke P. A. and Haskin L. A. (1972a) Rare earths and other trace elements in Apollo 15 samples (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 217–220. The Lunar Science Institute, Houston.
- Helmke P. A. and Haskin L. A. (1972b) Rare earths and other trace elements in Luna 16 soil. *Earth Planet. Sci. Lett.*, 13, 441–443.
- Helmke P. A., Haskin L. A., Korotev R. L., and Ziege K. E. (1972) Rare earths and other trace elements in Apollo 14 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1275–1292.
- Helmke P. A., Blanchard D. P., Jacobs J. W., and Haskin L. A. (1973) Rare earths, other trace elements and iron in Luna 20 samples. *Geochim. Cosmochim. Acta*, 37, 869–874.
- Hertogen J., Janssens M.-J., Takahashi H., Palme H., and Anders E. (1977) Lunar basins and craters: Evidence for systematic compositional changes of bombarding population. *Proc. Lunar Sci. Conf. 8th*, pp. 17–45.
- Heusser E. (1985) ³⁹Ar-⁴⁰Ar Datierungen von Apollo 14 Hochland Gesteinen. Diploma thesis, Max-Planck-Institut, Heidelberg. 45 pp.
- Hewins R. H. and Goldstein J. I. (1974) Metal-olivine associations and Ni-Co contents in two Apollo 12 mare basalts. *Earth Planet. Sci. Lett.*, 24, 59–70.
- Hewins R. H. and Goldstein J. I. (1975) The provenance of metal in anorthositic rocks. *Proc. Lunar Sci. Conf. 6th*, pp. 343–362.
- Heywood H. (1971) Particle size and shape distribution for lunar fines sample 12057,72. *Proc. Lunar Sci. Conf. 2nd*, pp. 1989–2001.
- Higuchi H. and Morgan J. W. (1975) Ancient meteoritic component in Apollo 17 boulders. *Proc. Lunar Sci. Conf. 6th*, pp. 1625–1651.
- Hintenberger H., Weber H. W., Voshage H., Wänke H., Begemann F., and Wlotzka F. (1970) Concentrations and isotopic abundances of the rare gases, hydrogen and nitrogen in Apollo 11 lunar matter. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1269–1282.

- Hintenberger H., Weber H. W., and Schultz L. (1974) Solar, spallogenic, and radiogenic rare gases in Apollo 17 soils and breccias. *Proc. Lunar Sci. Conf. 5th*, pp. 2005–2022.
- Hintenberger H., Schultz L., and Weber H. W. (1975) A comparison of noble gases in lunar fines and soil breccias: Implications for the origin of soil breccias. *Proc. Lunar Sci. Conf. 6th*, pp. 2262–2270.
- Hlava P. F., Prinz M., and Keil K. (1972) Niobian rutile in an Apollo 14 KREEP fragment. *Meteoritics*, 7, 479–485.
- Hobbs B. A., ed. (1980) Collective review papers presented at the 4th IAGA Workshop on Electromagnetic Induction in the Earth and Moon. *Geophys. Surv.*, 4, 3–185.
- Hodges C. A. and Wilhelms D. E. (1978) Formation of lunar basin rings. *Icarus*, 34, 294–323.
- Hodges C. A., Muehlberger W. R., and Ulrich G. E. (1973) Geologic setting of Apollo 16. *Proc. Lunar Sci. Conf. 4th*, pp. 1–25.
- Hodges F. N. and Kushiro I. (1974) Apollo 17 petrology and experimental determination of differentiation sequences in model Moon compositions. *Proc. Lunar Sci. Conf. 5th*, pp. 505–520.
- Hodges R. R. Jr. (1973) Helium and hydrogen in the lunar atmosphere. *J. Geophys. Res.*, 78, 8055–8064.
- Hodges R. R. Jr. (1975) Formation of the lunar atmosphere. *The Moon*, 14, 139–157.
- Hodges R. R. Jr. (1980) Lunar cold traps and their influence on argon-40. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 2463–2477.
- Hodges R. R. Jr., Hoffman J. H., and Johnson F. S. (1974) The lunar atmosphere. *Icarus*, 21, 415–426.
- Hoffman J. H. and Hodges R. R. Jr. (1975) Molecular gas species in the lunar atmosphere. *The Moon*, 14, 159–167.
- Hoffman J. H., Hodges R. R. Jr., Johnson F. S., and Evans D. E. (1973) Lunar atmospheric composition experiment. In *Apollo 17 Preliminary Science Report*, pp. 17–1 to 17–9. NASA SP-330.
- Hohenberg C. M., Marti K., Podosek F. A., Reedy R. C., and Shirck J. R. (1978) Comparisons between observed and predicted cosmogenic noble gases in lunar samples. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2311–2344.
- Holcomb R. (1971) Terraced depressions in lunar maria. *J. Geophys. Res.*, 76, 5703–5711.
- Hollister L. S. (1973) Sample 67955: A description and a problem. *Proc. Lunar Sci. Conf. 4th*, pp. 633–641.
- Hollister L. S. and Crawford M. L. (1977) Melt immiscibility in Apollo 15 KREEP: Origin of Fe-rich mare basalts. *Proc. Lunar Sci. Conf. 8th*, pp. 2419–2432.
- Hollister L. S. and Hargraves R. B. (1970) Compositional zoning and its significance in pyroxenes from two coarse grained Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 541–550.
- Hollister L. S., Trzcinski W. E. Jr., Hargraves R. B., and Kulick C. G. (1971) Petrogenetic significance of pyroxenes in two Apollo 12 samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 529–557.
- Holmes H. F., Fuller E. L., and Gammage R. B. (1973) Interaction of gases with lunar materials: Apollo 12, 14, and 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 2413–2423.
- Holmes H. F., Fuller E. L., and Gammage R. B. (1974) Some surface properties of Apollo 17 soils. *Proc. Lunar Sci. Conf. 5th*, pp. 2275–2285.
- Holsapple K. A. and Schmidt R. M. (1986) Point source solutions and coupling parameters in cratering mechanics. *J. Geophys. Res.*, 92, 6350–6376.
- Hood L. L. (1986) Geophysical constraints on the lunar interior. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds.), pp. 361–410. Lunar and Planetary Institute, Houston.
- Hood L. L. (1987) Magnetic field and remanent magnetization effects of basin-forming impacts on the Moon. *Geophys. Res. Lett.*, 14, 844–847.
- Hood L. L. and Williams C. R. (1989) The lunar swirls: Distribution and possible origins. *Proc. Lunar Planet. Sci. Conf. 19th*, pp. 99–113.
- Hood L. L., Coleman P. J., and Wilhelms D. E. (1979) Lunar nearside magnetic anomalies. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2235–2257.
- Hood L. L., Herbert F., and Sonett C. P. (1982a) Further efforts to limit lunar internal temperatures from electrical conductivity determinations. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A109–A116.
- Hood L. L., Herbert F., and Sonett C. P. (1982b) The deep lunar electrical conductivity profile, structural and thermal inferences. *J. Geophys. Res.*, 87, 5311–5326.
- Hood L. L., Sonett C. P., and Russell C. T. (1985) The next generation geophysical investigation of the Moon. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 253–263. Lunar and Planetary Institute, Houston.
- Horai K. and Winkler J. L. (1975) Thermal diffusivity of lunar rock sample 12002,85. *Proc. Lunar Sci. Conf. 6th*, pp. 3207–3215.
- Horai K. and Winkler J. L. (1976) Thermal diffusivity of four Apollo 17 rock samples. *Proc. Lunar Sci. Conf. 7th*, pp. 3183–3204.
- Horai K. and Winkler J. L. (1980) Thermal diffusivity of two Apollo 11 samples, 10020,44 and 10065,23: Effect of petrofabrics on the thermal conductivity of porous lunar rocks under vacuum. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1777–1788.
- Hörz F. (1968) Statistical measurements of deformation structures and refractive indices in experimentally shock loaded quartz. In *Shock Metamorphism of Natural Materials* (B. M. French and N. M. Short, eds.), pp. 243–254. Mono, Baltimore.
- Hörz F. (1977) Impact cratering and regolith dynamics. *Phys. Chem. Earth*, 10, 3–15.
- Hörz F. (1978) How thick are lunar mare basalts? *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3311–3331.
- Hörz F. (1985a) Lava tubes: Potential shelters for habitats. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 405–412. Lunar and Planetary Institute, Houston.

- Hörz F. (1985b) Mass extinctions and cosmic collisions: A lunar test. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 349–358. Lunar and Planetary Institute, Houston.
- Hörz F. and Quaide W. L. (1973) Debye-Scherrer investigations of experimentally shocked silicates. *The Moon*, 6, 45–82.
- Hörz F. and Schaal R. B. (1980) Asteroidal agglutinate formation and implications for asteroidal surfaces. *Icarus*, 46, 337–353.
- Hörz F., Gibbons R. V., Gault D. E., Hartung J. B., and Brownlee D. E. (1975) Some correlation of rock exposure ages and regolith dynamics. *Proc. Lunar Sci. Conf. 6th*, pp. 3495–3508.
- Hörz F., Gibbons R. V., Hill R. E., and Gault D. E. (1976) Large scale cratering of the lunar highlands: Some Monte Carlo model considerations. *Proc. Lunar Sci. Conf. 7th*, pp. 2931–2945.
- Hörz F., Gall H., Huttner R., and Oberbeck V. R. (1977) Shallow drilling in the “Bunte Breccia” impact deposits, Ries Crater, Germany. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 425–558. Pergamon, New York.
- Hörz F., Ostertag R., and Rainey D. A. (1983) Bunte Breccia of the Ries: Continuous deposits of large impact craters. *Rev. Geophys. Space Phys.*, 21, 1667–1725.
- Hörz F., Cintala M. J., See T. H., Cardenas F., and Thompson T. D. (1984) Grain size evolution and fractionation trends in an experimental regolith. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C183–C196.
- Houck K. J. (1982a) Petrologic variations in Apollo 16 surface soils. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A197–A209.
- Houck K. J. (1982b) Modal petrology of six soils from Apollo 16 double drive tube core 64002. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A210–A220.
- Housen K. R., Wilkening L. L., Chapman C. R., and Greenberg R. (1979) Asteroidal regoliths. *Icarus*, 39, 317–351.
- Housley R. M. and Morin F. J. (1972) Electrical conductivity of olivine and the lunar temperature profile. *The Moon*, 4, 35–38.
- Housley R. M., Grant R. W., and Abdel-Gawad M. (1972) Study of excess Fe metal in the lunar fines by magnetic separation, Mössbauer spectroscopy, and microscopic examination. *Proc. Lunar Sci. Conf. 3rd*, pp. 1065–1076.
- Housley R. M., Cirlin E. H., and Grant R. W. (1973a) Characterization of fines from the Apollo 16 site. *Proc. Lunar Sci. Conf. 4th*, pp. 2729–2735.
- Housley R. M., Grant R. W., and Patton N. E. (1973b) Origin and characteristics of excess Fe metal in lunar glass welded aggregates. *Proc. Lunar Sci. Conf. 4th*, pp. 2737–2749.
- Houston W. N. and Mitchell J. K. (1971) Lunar core tube sampling. *Proc. Lunar Sci. Conf. 2nd*, pp. 1953–1958.
- Houston W. N. and Namiq L. I. (1971) Penetration resistance of lunar soils. *J. Terramechanics*, 8, 59–69.
- Houston W. N., Hovland H. J., Mitchell J. K., and Namiq L. I. (1972) Lunar soil porosity and its variation as estimated from footprints and boulder tracks. *Proc. Lunar Sci. Conf. 3rd*, pp. 3255–3263.
- Houston W. N., Moriwaki Y., and Chang C.-S. (1973) Downslope movement of lunar soil and rock caused by meteoroid impact. *Proc. Lunar Sci. Conf. 4th*, pp. 2425–2435.
- Houston W. N., Mitchell J. K., and Carrier W. D. III (1974) Lunar soil density and porosity. *Proc. Lunar Sci. Conf. 5th*, pp. 2361–2364.
- Hovland H. J. and Mitchell J. K. (1971) *Mechanics of Rolling Sphere-Soil Slope Interaction*. Final Report, Vol. II of IV, NASA Contract 8–21432, Space Sciences Laboratory, Univ. of California, Berkeley.
- Hovland H. J. and Mitchell J. K. (1973) Boulder tracks and nature of lunar soil. *The Moon*, 6, 164–175.
- Howard K. A. and Muehlberger W. R. (1973) Lunar thrust faults in the Taurus-Littrow region. In *Apollo 17 Preliminary Science Report*, pp. 31–23 to 31–25. NASA SP-330.
- Howard K. A., Head J. W., and Swann G. A. (1972) Geology of Hadley Rille. *Proc. Lunar Sci. Conf. 3rd*, pp. 1–14.
- Howard K. A., Can M. H., and Muehlberger W. R. (1973) Basalt stratigraphy of southern Mare Serenitatis. In *Apollo 17 Preliminary Science Report*, pp. 29–1 to 29–12. NASA SP-330.
- Howard K. A., Wilhelms P. E., and Scott D. H. (1974) Lunar basin formation and highland stratigraphy. *Rev. Geophys. Space Phys.*, 12, 309–327.
- Hu H.-N. and Taylor L. A. (1978) Soils from Mare Crisium: Agglutinitic glass chemistry and soil development. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 291–302. Pergamon, New York.
- Hubbard N. J. (1979) Regional chemical variations in lunar basaltic lavas. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1753–1774.
- Hubbard N. J., Gast P. W., Meyer C., Nyquist L. E., Shih C.-Y., and Weismann H. (1971) Chemical composition of lunar anorthosites and their parent liquids. *Earth Planet. Sci. Lett.*, 13, 71–75.
- Hubbard N. J., Gast P. W., Rhodes J. M., Bansal B. M., Wiessman H., and Church S. E. (1972a) Nonmare basalts: Part II. *Proc. Lunar Sci. Conf. 3rd*, pp. 1161–1179.
- Hubbard N. J., Nyquist L. E., Rhodes J. M., Bansal B. M., Wiessman H., and Church S. E. (1972b) Chemical features of the Luna 16 regolith sample. *Earth Planet. Sci. Lett.*, 13, 423–428.
- Hubbard N. J., Rhodes J. M., Gast P. W., Bansal B. M., Shih C.-Y., Wiessman H., and Nyquist L. E. (1973) Lunar rock types: the role of plagioclase in non-mare and highland rock types. *Proc. Lunar Sci. Conf. 4th*, pp. 1297–1312.
- Hubbard N. J., Rhodes J. M., Wiessman H., Shih C.-Y., and Bansal B. (1974) The chemical definition and interpretation of rock types returned from the non-mare regions of the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 1227–1246.
- Hubbard N. J., Vinogradov A. P., Ramendik G. I., and Chupakhin M. S. (1977) New data for the Luna 20 core and a survey of published chemical data. In *The Soviet*

- American Conference on Cosmochemistry of the Moon and Planets* (J. H. Pomeroy and N. J. Hubbard, eds.), pp. 259–262. NASA SP-370.
- Hubner W., Kirsten T., and Kiko J. (1975) Rare gases in Apollo 17 soils with emphasis on analysis of size and mineral fractions of soil 74241. *Proc. Lunar Sci. Conf. 6th*, pp. 2009–2026.
- Huebner J. S., Lipin B. R., and Wiggins L. B. (1976) Partitioning of chromium between silicate crystals and melts. *Proc. Lunar Sci. Conf. 7th*, pp. 1195–1220.
- Huebner J. S., Duba A., Wiggins L. B., and Smith H. E. (1978) Electrical conductivity of orthopyroxene, measurements and implications. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 561–563.
- Huebner J. S., Duba A., and Wiggins L. B. (1979) Electrical conductivity of pyroxene which contains trivalent cations, laboratory measurements and the lunar temperature profile. *J. Geophys. Res.*, *84*, 4652–4656.
- Hughes D. W. (1978) Lunar atmosphere past and present. *Nature*, *273*, 489–490.
- Hughes S. S. and Schmitt R. A. (1984) Confirmation of Zr-Hf fractionation in lunar petrogenesis—an interim report (abstract). In *Lunar and Planetary Science XV*, pp. 385–386. Lunar and Planetary Institute, Houston.
- Hughes S. S. and Schmitt R. A. (1985) Sr-Hf-Ta fractionation during lunar evolution. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, *90*, D31–D45.
- Hughes T. C., Keays R. R., and Lovering J. F. (1973) Siderophile and volatile trace elements in Apollo 14, 15 and 16 rocks and fines: Evidence for extralunar component and Ti-, Au-, and Ag-enriched rocks in the ancient lunar crust (abstract). In *Lunar Science IV*, pp. 400–402. The Lunar Science Institute, Houston.
- Hughes V. A. (1962) Diffraction theory applied to radio wave scattering from the lunar surface. *Proc. Phys. Soc.*, *80*, 1117–1127.
- Hulme G. (1973) Turbulent lava flows and the formation of lunar sinuous rilles. *Mod. Geol.*, *4*, 107–117.
- Hundhausen A. J. (1972) *Coronal Expansion and Solar Wind*. Springer-Verlag, New York. 238 pp.
- Huneke J. C. (1978) ⁴⁰Ar-³⁹Ar microanalysis of single 74220 glass balls and 72435 breccia clasts. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2345–2362.
- Huneke J. C., Jessberger E. K., Podosek F. A., and Wasserburg G. J. (1973) ⁴⁰Ar-³⁹Ar measurements in Apollo 16 and 17 samples and the chronology of metamorphic and volcanic activity in the Taurus-Littrow region. *Proc. Lunar Sci. Conf. 4th*, pp. 1725–1756.
- Huner W., Kirsten T., and Kiko J. (1975) Rare gases in Apollo 17 soils with emphasis on analysis of size and mineral fractions of soil 74241. *Proc. Lunar Sci. Conf. 6th*, pp. 2009–2026.
- Hunt G. R. (1977) Spectral signatures of particulate minerals in the visible and near-infrared. *Geophysics*, *42*, 501–513.
- Husain L., Schaeffer O. A., Funkhouser J., and Sutter J. (1972) The ages of lunar material from Fra Mauro, Hadley Rille, and Spur Crater. *Proc. Lunar Sci. Conf. 3rd*, pp. 1557–1567.
- Hutcheon I. D., Macdougall D., and Price P. B. (1974) Improved determination of the long-term average Fe spectrum from 1 to 460 MeV/amu. *Proc. Lunar Sci. Conf. 5th*, pp. 2561–2576.
- Hutton R. E. and Evensen D. A. (1972) *Lunar Surface Models*. Report by TRW Systems Groups, Redondo Beach.
- Hutton V. R. S. (1976) The electrical conductivity of the earth and planets. *Rep. Prog. Phys.*, *39*, 487–572.
- Ip W.-H. (1986) Electrostatic charging and dust transport at Mercury's surface. *Geophys. Res. Lett.*, *13*, 1133–1136.
- Irvine W. M. (1966) The shadowing effect in diffuse reflection. *J. Geophys. Res.*, *71*, 2931–2937.
- Irving A. J. (1977) Chemical variation and fractionation of KREEP basalt magmas. *Proc. Lunar Sci. Conf. 8th*, pp. 2433–2448.
- Irving A. J. (1978) A review of experimental studies of crystal/liquid trace element partitioning. *Geochim. Cosmochim. Acta*, *42*, 743–770.
- Irving A. J., Merrill R. B., Singleton D. E. (1978) Experimental partitioning of rare earth elements and scandium among armalcolite, ilmenite, olivine and marebasalt liquid. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 601–612.
- Ishimaru A. (1978a) *Multiple Scattering Turbulence: Rough Surfaces and Remote Sensing Vol. 2*. Academic, New York. 572 pp.
- Ishimaru A. (1978b) *Single Scattering and Transport Theory: Wave Propagation and Scattering in Random Media, Vol. 1*. Academic, New York. 250 pp.
- Ivanov A. V., Ilin N. P., Loseva L. E., and Senin V. G. (1973a) Composition of metallic iron and some coexisting phases in samples from highland lunar region returned by automatic station Luna-20. *Geochimiya*, *12*, 1782–1792.
- Ivanov A. V., Tarasov L. S., Rode O. D., and Florensky K. P. (1973b) Comparative characteristics of regolith samples delivered from the lunar mare and highland regions by the automatic stations Luna-16 and Luna-20. *Proc. Lunar Sci. Conf. 4th*, pp. 351–364.
- Jackson E. D., Sutton R. L., and Wilshire H. G. (1975) Structure and petrology of a cumulus norite boulder sampled by Apollo 17 in Taurus-Littrow Valley, the Moon. *Geol. Soc. Am. Bull.*, *86*, 433–442.
- Jaffe L. D. (1964) Depth and strength of lunar dust. *Eos Trans. AGU*, *45*, 628.
- Jaffe L. D. (1965) Strength of the lunar dust. *J. Geophys. Res.*, *70*, 6139–6146.
- Jaffe L. D. (1967) Surface structure and mechanical properties of the lunar maria. *J. Geophys. Res.*, *72*, 1727–1731.
- Jaffe L. D. (1969) Lunar surface material: Spacecraft measurements of density and strength. *Science*, *164*, 1514–1516.
- Jaffe L. D. (1971a) Bearing strength of lunar soil. *The Moon*, *3*, 337–345.
- Jaffe L. D. (1971b) Cracking of lunar mare soil. *Nature*, *234*, 402–403.
- Jaffe L. D. (1973) Shear strength of lunar soil from Oceanus Procellarum. *The Moon*, *8*, 58–72.

- Jaffe L. D. et al. (1968) Principal science results from the Surveyor project. In *Surveyor Project Final Report, Part 2: Science Results*, pp. 15–20. JPL Tech. Rpt. 32–1265, Jet Propulsion Laboratory, Pasadena.
- James O. D. (1973) *crystallization History of Lunar Basalt 14310*. U.S. Geol. Surv. Prof. Pap. 841. 29 pp.
- James O. B. (1976) Petrology of aphanitic lithologies in consortium breccia 73215. *Proc. Lunar Sci. Conf. 7th*, pp. 2145–2178.
- James O. B. (1977) Lunar highlands breccias generated by major impacts. In *The Soviet-American Conference on Cosmochemistry of the Moon and Planets* (J. H. Pomeroy and N. J. Hubbard, eds.), pp. 637–658. NASA SP-370.
- James O. B. (1980) Rocks of the early lunar crust. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 365–393.
- James O. B. (1981) Petrologic and age relations in Apollo 16 rocks: Implications for subsurface geology and the age of the Nectaris basin. *Proc. Lunar Planet. Sci. 12B*, pp. 209–233.
- James O. B. and Flohr M. K. (1983) Subdivision of the Mg-suite noritic rocks into Mg-gabbronorites and Mg-norites. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 88, A603–A614.
- James O. B. and Hammarstrom J. G. (1977) Petrology of four clasts from consortium breccia 73215. *Proc. Lunar Sci. Conf. 8th*, pp. 2459–2494.
- James O. B. and Hörz F., eds. (1981) *Workshop on Apollo 16*. LPI Tech. Rpt. 81–01, Lunar and Planetary Institute, Houston. 157 pp.
- James O. B., Lindstrom M. M., and Flohr M. K. (1983) Petrology and geochemistry of alkali gabbronorites from lunar breccia 67975. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E314–E330.
- James O. B., Flohr M. K., and Lindstrom M. M. (1984) Petrology and chemistry of lunar dimict breccia 61015. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C63–C86.
- James O. B., Lindstrom M. M., and Flohr M. K. (1987) Petrology and geochemistry of alkali gabbronorites from lunar breccia 67975. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E314–E330.
- Jeffreys H. (1962) *The Earth*. Cambridge Univ., Cambridge. 438 pp.
- Jerde E. A., Warren P. H., Morris R. V., Heiken G. H., and Vaniman D. T. (1987) A potpourri of regolith breccias: "New" samples from the Apollo 14, 16 and 17 landing sites. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E526–E536.
- Jerome D. Y. and Philippot J.-C. (1973) Chemical composition of Luna 20 soil and rock fragments. *Geochim. Cosmochim. Acta*, 37, 909–914.
- Jerome D. Y., Philippot J.-C., and Brichet E. (1972) Determination of 29 elements in Luna 16 soil by non-destructive activation analysis. *Earth Planet. Sci. Lett.*, 13, 436–440.
- Jessberger E. K. (1983) ^{40}Ar - ^{39}Ar dating of North Ray Crater ejecta (abstract). In *Lunar and Planetary Science XIV*, pp. 349–350. Lunar and Planetary Institute, Houston.
- Jessberger E. K., Huneke J. C., Podosek F. A., and Wasserburg G. J. (1974) High-resolution argon analysis of neutron-irradiated Apollo 16 rocks and separated minerals. *Proc. Lunar Sci. Conf. 5th*, pp. 1419–1449.
- Jessberger E. K., Dominik B., Kirsten T., and Staudacher T. (1977) New ^{40}Ar - ^{39}Ar ages of Apollo 16 breccias and 4.42 AE old anorthosites (abstract). In *Lunar Science VIII*, pp. 511–513. The Lunar Science Institute, Houston.
- Johnson F. S., Evans D. E., and Carroll J. M. (1970) Cold cathode gage (lunar atmosphere detector). In *Apollo 12 Preliminary Science Report*, pp. 93–97. NASA SP-235.
- Johnson F. S., Carroll J. M., and Evans D. E. (1972) Lunar atmosphere measurements. *Proc. Lunar Sci. Conf. 3rd*, pp. 2231–2242.
- Johnson N. L. (1979) *Handbook of Soviet Lunar and Planetary Exploration*. American Astronautical Society, Science and Technology Series Vol. 47. 262 pp.
- Johnson T. V., Mosher J. A., and Matson D. L. (1977) Lunar spectral units: A northern hemispheric mosaic. *Proc. Lunar Sci. Conf. 8th*, pp. 1013–1028.
- Jones J. H. and Drake M. J. (1982) An experimental geochemical approach to early planetary differentiation (abstract). In *Lunar and Planetary Science XIII*, pp. 369–370. Lunar and Planetary Institute, Houston.
- Jones J. H. and Drake M. J. (1986) Geochemical constraints on core formation in the Earth. *Nature*, 322, 221–228.
- Jovanovic S. and Reed G. W. Jr. (1973) Volatile trace elements and the characterization of the Cayley Formation and the primitive lunar crust. *Proc. Lunar Sci. Conf. 4th*, pp. 1313–1324.
- Jovanovic S. and Reed G. W. Jr. (1974) Labile and nonlabile element relationships among Apollo 17 samples. *Proc. Lunar Sci. Conf. 5th*, pp. 1685–1701.
- Jovanovic S. and Reed G. W. Jr. (1975) Cl and P₂O₅ systematics: Clues to early lunar magmas. *Proc. Lunar Sci. Conf. 6th*, pp. 1737–1751.
- Jovanovic S. and Reed G. W. Jr. (1976a) Convection cells in the early lunar magma ocean: Trace-element evidence. *Proc. Lunar Sci. Conf. 7th*, pp. 3447–3459.
- Jovanovic S. and Reed G. W. Jr. (1976b) Trace elements and the evolution of lunar rocks (abstract). In *Lunar Science VII*, pp. 437–439. The Lunar Science Institute, Houston.
- Jovanovic S. and Reed G. W. Jr. (1977) Trace element geochemistry and the early lunar differentiation. *Proc. Lunar Sci. Conf. 8th*, pp. 623–632.
- Jovanovic S. and Reed G. W. Jr. (1978) Trace element evidence for a laterally inhomogeneous Moon. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 59–80.
- Jovanovic S. and Reed G. W. Jr. (1979) Regolith layering processes based on studies of low-temperature volatile elements in Apollo core samples. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1425–1435.
- Jovanovic S. and Reed G. W. Jr. (1980a) Cl, P₂O₅, U and Br associated with mineral separates from a low and a high Ti mare basalt. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 125–134.
- Jovanovic S. and Reed G. W. Jr. (1980b) Candidate samples for the earliest lunar crust. In *Proceedings of the*

- Conference on the Lunar Highlands Crust (J. J. Papike and R. B. Merrill, eds.), pp. 101–111. Pergamon, New York.
- Jovanovic S. and Reed G. W. Jr. (1981) Aspects of the history of 66095 based on trace elements in clasts and whole rock. *Proc. Lunar Planet. Sci. 12B*, pp. 295–304.
- Jovanovic S., Jensen K. J., and Reed G. W. Jr. (1978) Luna 24 origins: Some trace element constraints. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 695–700. Pergamon, New York.
- Juan V. C., Chen J. C., Huang C. K., Chen P. Y., and Wang Lee C. M. (1972) Petrology and chemistry of some Apollo 14 lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 687–705.
- Kaczaral P. W., Dennison J. E., and Lipschutz M. E. (1986) Yamato-791197: A volatile trace element rock lunar highlands sample from Antarctica. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 76–83. Natl. Inst. for Polar Res., Tokyo.
- Kallemeyn G. W. and Warren P. H. (1983) Compositional implications regarding the lunar origin of the ALHA81005 meteorite. *Geophys. Res. Lett.*, 10, 833–836.
- Kaplan I. R. and Petrowski C. (1971) Carbon and sulfur isotope studies on Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1397–1406.
- Kaplan I. R., Smith J. W., and Ruth E. (1970) Carbon and sulfur concentration and isotopic composition in Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1317–1330.
- Kaplan I. R., Kerridge J. F., and Petrowski C. (1976) Light element geochemistry of the Apollo 15 site. *Proc. Lunar Sci. Conf. 7th*, pp. 481–492.
- Katsube T. J. and Collett L. S. (1971) Electrical properties of Apollo 11 and Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 2367–2379.
- Katsube T. J. and Collett L. S. (1973a) Electrical characteristics of Apollo 16 lunar samples. *Proc. Lunar Sci. Conf. 4th*, pp. 3101–3110.
- Katsube T. J. and Collett L. S. (1973b) Electrical characteristics of rocks and their application to planetary and terrestrial EM-sounding. *Proc. Lunar Sci. Conf. 4th*, pp. 3111–3131.
- Kaula W. M. (1968) *An Introduction to Planetary Physics: The Terrestrial Planets*. Wiley, New York. 490 pp.
- Keaton P. W. (1985) A Moon base/Mars base transportation depot. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 141–154. Lunar and Planetary Institute, Houston.
- Keays R. R., Ganapathy R., Laul J. C., Anders E., Herzog G. F., and Jeffery P. M. (1970) Trace elements and radioactivity in lunar rocks: Implications for meteorite infall, solar-wind flux, and formation conditions of the Moon. *Science*, 167, 490–493.
- Keihm S. J. and Langseth M. G. (1973) Surface brightness temperature at the Apollo 17 heat flow site: Thermal conductivity of the upper 15 cm of regolith. *Proc. Lunar Sci. Conf. 4th*, pp. 2503–2513.
- Keihm S. J. and Langseth M. G. (1975a) Lunar microwave brightness temperature observations reevaluated in the light of Apollo program findings. *Icarus*, 24, 211–230.
- Keihm S. J. and Langseth M. G. (1975b) Microwave emission spectrum of the Moon: Mean global heat flow and average depth of the regolith. *Science*, 187, 64–66.
- Keihm S. J., Peters K., Langseth M. G., and Chute J. L. (1973) Apollo 15 measurement of lunar surface brightness temperatures: Thermal conductivity of the upper 1.5 meters of regolith. *Earth Planet. Sci. Lett.*, 19, 337–351.
- Keil K., Bunch T. E., and Prinz M. (1970) Mineralogy and composition of Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 561–598.
- Keil K., Prinz M., and Bunch T. E. (1971) Mineralogy, petrology and chemistry of some Apollo 12 samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 319–341.
- Keil K., Kurat G., Prinz M., and Green J. (1972) Lithic fragments, glasses and chondrules from Luna 16 fines. *Earth Planet. Sci. Lett.*, 13, 243–256.
- Kerridge J. F. (1975) Solar nitrogen: Evidence for a secular change in the ratio of nitrogen-15 to nitrogen-14. *Science*, 188, 162–164.
- Kerridge J. F. (1980) Secular variations in composition of the solar wind: Evidence and causes. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 475–489. Pergamon, New York.
- Kerridge J. F. (1989) What has caused the secular increase in solar nitrogen-15? *Science*, 245, 480–486.
- Kerridge J. F. and Kaplan I. R. (1978) Sputtering: Its relationship to isotopic fractionation on the lunar surface. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1687–1709.
- Kerridge J. F., Kaplan I. R., and Petrowski C. (1975a) Evidence for meteoritic sulfur in the lunar regolith. *Proc. Lunar Sci. Conf. 6th*, pp. 2151–2162.
- Kerridge J. F., Kaplan I. R., Petrowski C., and Chang S. (1975b) Light element geochemistry of the Apollo 16 site. *Geochim. Cosmochim. Acta*, 39, 137–162.
- Kesson S. E. (1975) Mare basalts: Melting experiments and petrogenetic interpretations. *Proc. Lunar Sci. Conf. 6th*, pp. 921–944.
- Kesson S. E. and Lindsley D. H. (1975) The effect of Al³⁺, Cr³⁺, and Ti³⁺ on the stability of armalcolite. *Proc. Lunar Sci. Conf. 6th*, pp. 911–920.
- Kesson S. E. and Lindsley D. H. (1976) Mare basalt petrogenesis—a review of experimental studies. *Rev. Geophys. Space Phys.*, 14, 361–373.
- Kharkar D. P. and Turekian K. K. (1971) Analyses of Apollo 11 and Apollo 12 rocks and soils by neutron activation. *Proc. Lunar Sci. Conf. 2nd*, pp. 1301–1305.
- Kieffer S. W. (1971) Shock metamorphism of the Coconino Sandstone at Meteor Crater, Arizona. *J. Geophys. Res.*, 76, 5449–5473.
- Kieffer S. W. (1975) From regolith to rock by shock. *The Moon*, 13, 301–320.
- Kiko J., Warhaut M., and Kirsten T. (1979) Solar wind noble gas distribution in lunar ilmenites and correlated element fractionation (abstract). In *Lunar and Planetary Science X*, pp. 664–666. Lunar and Planetary Institute, Houston.
- King E. A. Jr. and Butler J. C. (1977) Rosin's law and the lunar regolith. *The Moon*, 17, 177–178.

- King E. A. Jr., Carman M. F., and Butler J. C. (1970) Mineralogy and petrology of coarse particulate material from the lunar surface at Tranquility Base. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 599–606.
- King J. H. (1974) Solar proton fluences for 1977–1983 space missions. *J. Spacecraft Rockets*, 11, 401–408.
- Kinslow R., ed. (1970) *High-Velocity Impact Phenomena*. Academic, New York. 575 pp.
- Kipp M. E. and Melosh H. J. (1986) Short note: A preliminary numerical study of colliding planets. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds.), pp. 643–647. Lunar and Planetary Institute, Houston.
- Kirsten T. and Horn P. (1974) Chronology of the Taurus-Littrow region III: Ages of mare basalts and highland breccias and some remarks about the interpretation of highland rocks. *Proc. Lunar Sci. Conf. 5th*, pp. 1451–1475.
- Kirsten T., Horn P., and Kiko J. (1973) ^{39}Ar - ^{40}Ar dating and rare gas analysis of neutron-irradiated Apollo 16 rocks and soils. *Proc. Lunar Sci. Conf. 4th*, pp. 1757–1784.
- Klein C. Jr. and Drake J. C. (1972) Mineralogy, petrology, and surface features of some fragmental material from the Fra Mauro site. *Proc. Lunar Sci. Conf. 3rd*, pp. 1095–1113.
- Klein C. Jr., Drake J. C., and Frondel C. (1971) Mineralogical, petrological, and chemical features of four Apollo 12 lunar microgabbros. *Proc. Lunar Sci. Conf. 2nd*, pp. 265–284.
- Koch G. S. Jr. and Link R. F. (1970) *Statistical Analysis of Geological Data*. Wiley, New York. 375 pp.
- Koeberl C., Warren P. H., Lindstrom M. M., Spettel B., and Fukuoka T. (1989) Preliminary examination of the Yamato-86032 lunar meteorite: II. Major and trace element chemistry. In *Proceedings of the Thirteenth Symposium on Antarctic Meteorites*, pp. 15–24. Natl. Inst. for Polar Res., Tokyo.
- Kohl J. W., Boström C. O., and Williams D. J. (1973) Particle observations of the August 1972 solar events by Explorers 41 and 43. In *Collected Data Reports on August 1972 Solar-Terrestrial Events* (H. E. Coffey, ed.), pp. 330–333. Report UAG-28, Part II, World Data Center A for Solar-Terrestrial Physics, NOAA, Boulder, Colorado.
- Kolesov G. M. and Surkov Yu. A. (1980) Neutron-activation analysis of regolith samples from Mare Crisium. In *Lunar Soil from Mare Crisium* (V. L. Barsukov, ed.), pp. 238–243. Nauka, Moscow.
- Kordesh K. (1983a) Comparative Fourier grain shape analysis of meteoritic breccias and lunar soils (abstract). In *Lunar and Planetary Science XIV*, pp. 387–388. Lunar and Planetary Institute, Houston.
- Kordesh K. (1983b) Fourier grain analysis of clasts in achondrites utilizing shape frequency distributions (abstract). *Meteoritics*, 18, 327.
- Kordesh K., Blakely R., Basu A., and Pachut J. (1982) Fourier grain shape analysis of clasts in a chondrite (abstract). *Meteoritics*, 17, 236.
- Korotev R. L. (1976) Geochemistry of grain-size fractions of soils from the Taurus-Littrow valley floor. *Proc. Lunar Sci. Conf. 7th*, pp. 695–726.
- Korotev R. L. (1981) Compositional trends in Apollo 16 soils. *Proc. Lunar Planet. Sci. 12B*, pp. 577–605.
- Korotev R. L. (1982) Comparative geochemistry of Apollo 16 surface soils and samples from cores 64002 and 60002 through 60007. *Proc. Lunar Planet. Sci. Conf. 13th, J. Geophys. Res.*, 87, A269–A278.
- Korotev R. L. (1985) Geochemical survey of Apollo 15 regolith breccias (abstract). In *Lunar and Planetary Science XVI*, pp. 459–460. Lunar and Planetary Institute, Houston.
- Korotev R. L. (1987a) The meteoritic component of Apollo 16 noritic impact melt breccias. *Proc. Lunar Planet. Sci. Conf. 17th, Geophys. Res.*, 92, E491–E512.
- Korotev R. L. (1987b) The nature of the meteoritic components of Apollo 16 soil, as inferred from correlations of iron, cobalt, iridium, and gold with nickel. *Proc. Lunar Planet. Sci. Conf. 17th, Geophys. Res.*, 92, E447–E461.
- Korotev R. L. and Haskin L. A. (1987) Does the lunar crust have a Eu anomaly? (abstract). In *Lunar and Planetary Science XVIII*, pp. 507–508. Lunar and Planetary Institute, Houston.
- Korotev R. L., Haskin L. A., and Lindstrom M. M. (1980) A synthesis of lunar highlands compositional data. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 395–429.
- Korotev R. L., Lindstrom M. M., Lindstrom D. J., and Haskin L. A. (1983) Antarctic meteorite ALHA81005—not just another lunar anorthositic breccia. *Geophys. Res. Lett.*, 10, 829–832.
- Korotev R. L., Morris R. V., and Lauer H. V. (1984) Stratigraphy and geochemistry of the Stone Mountain double drive tube (64001/2). *Proc. Lunar Planet. Sci. Conf. 15th, in J. Geophys. Res.*, 89, C143–C160.
- Kosofsky L. J. and El-Baz F. (1970) *The Moon as Viewed by Lunar Orbiter*. NASA SP-200. 152 pp.
- Kothari B. K. and Goel P. S. (1973) Nitrogen in lunar samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1587–1596.
- Kovach R. L. and Watkins J. S. (1973) The velocity structure of the lunar crust. *The Moon*, 7, 63–75.
- Krähenbühl U. (1980) Distribution of volatile and non-volatile elements in grain-size fractions of Apollo 17 drive tube 74001/2. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1551–1564.
- Krähenbühl U., Ganapathy R., Morgan J. W., and Anders E. (1973) Volatile elements in Apollo 16 samples: Implications for highland volcanism and accretion history of the Moon. *Proc. Lunar Sci. Conf. 4th*, pp. 1325–1348.
- Krähenbühl U., Grütter A., von Gunten H. R., Meyer G., Wegmüller F., and Wyttenbach A. (1977) Volatile and non-volatile elements in grain size fractions of Apollo 17 soils 75081, 72461 and 72501. *Proc. Lunar Sci. Conf. 8th*, pp. 3901–3916.
- Krotikov V. D. (1962) Some electrical properties of earth rocks and their comparison with those of the lunar surface layer. *Izv. Vyssh. Uchebn. Zaved. Radiofiz.*, 5, 1057–1061.
- Krotikov V. D. and Troitsky V. S. (1963) Radio emission and the nature of the Moon. *Usp. Fiz. Nauk.*, 81, 589–639.

- Krotikov V. D. and Troitsky V. S. (1964) Detecting heat flow from the interior of the Moon. *Soviet Astron.*, 7, 822–826.
- Kroupenio N. N. (1972) Some characteristics of the Venus surface. *Icarus*, 17, 692–698.
- Kroupenio N. N. (1973) Results of radar experiments performed on automatic stations Luna 16 and Luna 17. In *COSPAR Space Research XIII*, pp. 969–973. Akademie-Verlag, Berlin.
- Kroupenio N. N., Balo A. G., Ruzskii E. G., Ladyghin V. A., Cherkasov V. V., and Fomin V. S. (1975) Results of radar experiments performed aboard the Luna 19 and 20 automatic stations. In *COSPAR Space Research XV*, pp. 615–620. Akademie-Verlag, Berlin.
- Kuiper G. P., ed. (1960) *Photographic Lunar Atlas*. Univ. of Chicago, Chicago. 23 pp.
- Kuiper G. P. (1965) Surface structure of the Moon. In *The Nature of the Lunar Surface* (W. N. Hess, D. Menzel, and J. A. O'Keefe, eds.), Chapter 4. Johns Hopkins, Baltimore.
- Kurat G., Keil K., and Prinz M. (1974) Rock 14318: A polymict lunar breccia with chondritic texture. *Geochim. Cosmochim. Acta*, 38, 1133–1146.
- Kushiro I. and Nakamura Y. (1970) Petrology of some lunar crystalline rocks. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 607–626.
- Lakatos S., Heymann D., and Yaniv A. (1973) Green spherules from Apollo 15: Inferences about their origin from inert gas measurements. *The Moon*, 7, 131–148.
- Lambe T. W. and Whitman R. V. (1969) *Soil Mechanics*. Wiley, New York. 553 pp.
- Lambeck K. (1975) Effects of tidal dissipation in the oceans on the Moon's orbit and the Earth's rotation. *J. Geophys. Res.*, 80, 2917–2925.
- Lammlin D. R. (1977) Lunar seismicity and tectonics. *Phys. Earth Planet. Inter.*, 14, 224–273.
- Lammlin D. R., Latham G. V., Dorman J., Nakamura Y., and Ewing M. (1974) Lunar seismicity, structure, and tectonics. *Rev. Geophys. Space Phys.*, 12, 1–21.
- Lange M. A. and Ahrens T. J. (1979) Impact melting early in lunar history. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2707–2725.
- Langevin Y. (1982) Evolution of an asteroidal regolith: Granulometry, mixing and maturity. In *Workshop on Lunar Breccias and Soils and Their Meteoritic Analogs* (G. J. Taylor and L. L. Wilkening, eds.), pp. 87–93. LPI Tech. Rpt. 82–02, Lunar and Planetary Institute, Houston.
- Langevin Y. and Arnold J. R. (1977) The evolution of the lunar regolith. *Annu. Rev. Earth Planet. Sci.*, 5, 449–489.
- Langseth M. G. and Keihm S. J. (1977) In-situ measurements of lunar heat flow. In *Soviet-American Conference on Geochemistry of the Moon and Planets*, pp. 283–293. NASA SP-370.
- Langseth M. G. Jr., Clark S. P. Jr., Chute J. L. Jr., Keihm S., and Wechsler A.E. (1972) Heat-flow experiment. In *Apollo 15 Preliminary Science Report*, pp. 11–1 to 11–23. NASA SP-289.
- Langseth M. G. Jr., Keihm S. J., and Chute J. L. Jr. (1973) Heat-flow experiment. In *Apollo 17 Preliminary Science Report*, pp. 9–1 to 9–24. NASA SP-330.
- Langseth M. G., Keihm S. J., and Peters K. (1976) Revised lunar heat-flow values. *Proc. Lunar Sci. Conf. 7th*, pp. 3143–3171.
- Lanzerotti L. J. and Brown W. L. (1981) Ice in the polar regions of the moon. *J. Geophys. Res.*, 86, 3949–3950.
- LAPST (Lunar and Planetary Sample Team) (1985) *Horizons and Opportunities in Lunar Sample Science*. LPI Tech. Rpt. 85–04, Lunar and Planetary Institute, Houston. 32 pp.
- Latham G. V., McDonald W. G., and Moore H. J. (1970a) Missile impacts as sources of seismic energy on the Moon. *Science*, 168, 242–245.
- Latham G. V., Ewing M., Dorman J., Press F., Toksoz M. N., Sutton G., Meissner R., Duennebie F., Nakamura Y., Kovach R., and Yates M. (1970b) Seismic data from manmade impacts on the Moon. *Science*, 170, 620–626.
- Latham G. V., Ewing M., Press F., Sutton G., Dorman J., Nakamura Y., Toksoz N., Wiggins R., Derr J., and Duennebie F. (1970c) Apollo 11 passive seismic experiment. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 2309–2320.
- Latham G., Ewing M., Dorman J., Press F., Toksoz N., Sutton G., Duennebie F., and Nakamura Y. (1972) Moonquakes and lunar tectonism. *The Moon*, 4, 3–12.
- Latham G. V., Dorman H. J., Horvath P., Ibrahim A. K., Koyama J., and Nakamura Y. (1978) Passive seismic experiment: A summary of current status. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3609–3613.
- Laul J. C. and Papike J. J. (1980) The lunar regolith: Comparative chemistry of the Apollo sites. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1307–1340.
- Laul J. C. and Schmitt R. A. (1973a) Chemical composition of Luna 20 rocks and soil and Apollo 16 soils. *Geochim. Cosmochim. Acta*, 37, 927–942.
- Laul J. C. and Schmitt R. A. (1973b) Chemical composition of Apollo 15, 16 and 17 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1349–1367.
- Laul J. C. and Schmitt R. A. (1975a) Dunite 72417: A chemical study and interpretation. *Proc. Lunar Sci. Conf. 6th*, pp. 1231–1254.
- Laul J. C. and Schmitt R. A. (1975b) Chemical composition of Apollo 17 samples: Boulder breccias (2), rake breccias (8), and others (abstract). In *Lunar Science VI*, pp. 489–491. The Lunar Science Institute, Houston.
- Laul J. C., Morgan J. W., Ganapathy R., and Anders E. (1971) Meteoritic material in lunar samples: Characterization from trace elements. *Proc. Lunar Sci. Conf. 2nd*, pp. 1139–1158.
- Laul J. C., Wakita H., Showalter D. L., Boynton W. V., and Schmitt R. A. (1972a) Bulk, rare earth, and other trace elements in Apollo 14 and 15 and Luna 16 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1181–1201.
- Laul J. C., Ganapathy R., Morgan J. W., and Anders E. (1972b) Meteoritic and non-meteoritic trace elements in Luna 16 samples. *Earth Planet. Sci. Lett.*, 13, 450–454.
- Laul J. C., Hill D. W., and Schmitt R. A. (1974) Chemical studies of Apollo 16 and 17 samples. *Proc. Lunar Sci. Conf. 5th*, pp. 1047–1066.

- Laul J. C., Vaniman D. T., Papike J. J., and Simon S. (1978a) Chemistry and petrology of size fractions of Apollo 17 deep drill core 70009-70006. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2065-2097.
- Laul J. C., Vaniman D. T., and Papike J. J. (1978b) Chemistry, mineralogy and petrology of seven >1 mm fragments from Mare Crisium. In *Mare Crisium: The View from Luna 24* (J. J. Papike and R. B. Merrill, eds.), pp. 537-568. Pergamon, New York.
- Laul J. C., Papike J. J., and Simon S. B. (1981) The lunar regolith: Comparative studies of the Apollo and Luna sites. Chemistry of soils from Apollo 17, Luna 16, 20, and 24. *Proc. Lunar Planet. Sci. 12B*, pp. 389-407.
- Laul J. C., Smith M. R., and Schmitt R. A. (1983) ALHA 81005 meteorite: Chemical evidence for a lunar highland origin. *Geophys. Res. Lett.*, 10, 825-828.
- Laul J. C., Smith M. R., Papike J. J., and Simon S. B. (1984) Agglutinates as recorders of regolith evolution: Application to the Apollo 17 drill core. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C161-C170.
- Laul J. C., Rode O. D., Simon S. B., and Papike J. J. (1987) The lunar regolith: Chemistry and petrology of Luna 24 grain size fractions. *Geochim. Cosmochim. Acta*, 51, 661-673.
- Leich D. A., Kahl S. B., Kirschbaum A. R., Niemeyer S., and Phinney D. (1975) Rare gas constraints on the history of Boulder 1, Station 2, Apollo 17. *The Moon*, 14, 407-444.
- Leonovich A. K., Gromov V. V., Rybakov A. V., Petrov V. K., Pavlov P. S., Cherkasov I. I., and Shvarev V. V. (1971) Studies of lunar ground mechanical properties with the self-propelled Lunokhod-1. In *Peredvizhnaya Laboratoriya na Luna-Lunokhod-1 ('Lunokhod 1'—Mobile Lunar Laboratory)*, pp. 120-135. Nauka, Moscow.
- Leonovich A. K., Gromov V. V., Rybakov A. V., Petrov V. N., Pavlov P. S., Cherkasov I. I., and Shvarev V. V. (1972) Investigations of the mechanical properties of the lunar soil along the path of Lunokhod I. In *COSPAR Space Research XII*, pp. 53-64. Akademie-Verlag, Berlin.
- Leonovich A. K., Gromov V. V., Dmitriyev A. D., Penetrigov V. N., Semenov P. S., and Shvarev V. V. (1974a) The main peculiarities of the processes of the deformation and destruction of lunar soil. In *The Soviet American Conference on Cosmochemistry of the Moon and Planets*, pp. 735-743. NASA SP-370 (1977); also available in NASA Technical Translation F-16034 (1974).
- Leonovich A. K., Gromov V. V., Dmitriyev A. D., Loshkin V. A., Pavlov P. S., Rybakov A. V., and Shvarev V. V. (1974b) The results of investigations of the physical and mechanical properties of lunar soil in nitrogen gas within a research box. In *Lunar Soil from Sea of Fertility*, pp. 563-570. Nauka, Moscow (in Russian).
- Leonovich A. K., Gromov V. V., Semyonov P. S., Penetrigov V. N., and Shvartov V. V. (1975) Luna 16 and 20 investigations of the physical and mechanical properties of lunar soil. In *COSPAR Space Research XV*, pp. 607-616. Akademie-Verlag, Berlin.
- Letaw J. R., Silberberg R., and Tsao C. H. (1987) Radiation hazards on space missions. *Nature*, 330, 709-710.
- Levinson A. A. and Taylor S. R. (1971) *Moon Rocks and Minerals*. Pergamon, New York. 222 pp.
- Levy C., Christophe-Michel-Levy M., Picot P., and Caye R. (1972) A new titanium and zirconium oxide from the Apollo 14 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1115-1120.
- Lewis J. S., Jones T. D., and Farrand W. H. (1988) Carbonyl extraction of lunar and asteroidal materials. In *Engineering Construction and Operations in Space: Proceedings of Space '88* (S. W. Johnson and J. P. Wetzel, eds.), pp. 111-122. American Society of Civil Engineers, New York.
- LGO Science Workshop Members (1986) *Contributions of a Lunar Geoscience Observer (LGO) Mission to Fundamental Questions in Lunar Science*. Southern Methodist Univ., Dallas, Texas. 86 pp.
- Lightner B. D. and Marti K. (1974) Lunar trapped xenon. *Proc. Lunar Sci. Conf. 5th*, pp. 2023-2031.
- Lin R. P., Anderson K. A., Bush R., McGuire R. E., and McCoy J. E. (1976) Lunar surface remanent magnetic fields detected by the electron reflection method. *Proc. Lunar Sci. Conf. 7th*, pp. 269 1-2703.
- Lin R. P., Anderson K. A., and Hood L. L. (1988) Lunar surface magnetic field concentrations antipodal to young large impact basins. *Icarus*, 74, 529-541.
- Lincoln Laboratory (1970) *Radar Studies of the Moon*. Final report, NASA Contract NAS-9-7830. MIT, Lexington. 50 pp.
- Lindsay J. F. (1973) Evolution of lunar soil grain size and shape parameters. *Proc. Lunar Sci. Conf. 4th*, pp. 215-224.
- Lindsay D. H. (1967) The join hedenbergite-ferrosilite at high pressures and temperatures. *Carnegie Inst. Wash. Yearb.*, 65, 230-232.
- Lindsay D. H. and Burnham C. W. (1970) Pyroxferroite: Stability and X-ray crystallography of synthetic $\text{Ca}_{0.15}\text{Fe}_{0.85}\text{SiO}_3$ pyroxenoid. *Science*, 168, 364-367.
- Lindsay D. H. and Munoz J. L. (1969) Subsolidus relations along the join hederbergite-ferrosilite. *Am. J. Sci.*, 267A, 295-324.
- Lindsay D. H., Papike J. J., and Bence A. E. (1972) Pyroxferroite: Breakdown at low pressure and high temperature (abstract). In *Lunar Science III*, pp. 483-485. The Lunar Science Institute, Houston.
- Lindsay D. H., Kesson S. E., Hartzman M. J., and Cushman M. K. (1974) The stability of armalcolite: Experimental studies in the system Mg-Fe-Ti-O. *Proc. Lunar Sci. Conf. 5th*, pp. 521-534.
- Lindstrom D. J. (1976) Experimental study of the partitioning of the transition metals between clinopyroxene and coexisting silicate liquids. Ph.D. thesis, Univ. of Oregon. 188 pp.
- Lindstrom D. J. and Semkow K. W. (1986) Electrochemical monitoring of crystal growth for silicate melts. In *Lunar and Planetary Science XVII*, pp. 484-485. Lunar and Planetary Institute, Houston.
- Lindstrom D. J., Haskin L. A., Semkow K. W., and Lewis R. H. (1986) Conductivities of silicate melts; applications to lunar smelting (abstract). In *Lunar and Planetary Science XVII*, pp. 482-483. Lunar and Planetary Institute, Houston.

- Lindstrom M. M. (1984) Alkali gabbro-norite, ultra-KREEPY melt rock and the diverse suite of clasts in North Ray Crater feldspathic fragmental breccia 67975. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C50-C62.
- Lindstrom M. M. and Lindstrom D. J. (1986) Lunar granulites and their precursor anorthositic norites of the early lunar crust. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D263-D276.
- Lindstrom M. M., Duncan A. R., Fruchter J. S., McKay S. M., Stoesser J. W., Goles G. G., and Lindstrom D. J. (1972) Compositional characteristics of some Apollo 14 clastic materials. *Proc. Lunar Sci. Conf. 3rd*, pp. 1201-1215.
- Lindstrom M. M., Nava D. F., Lindstrom D. J., Winzer S. R., Lum R. K. L., Schuhmann P. J., Schuhmann S., and Philpotts J. A. (1977a) Geochemical studies of the white breccia boulders at North Ray Crater, Descartes region of the lunar highlands. *Proc. Lunar Sci. Conf. 8th*, pp. 2137-2151.
- Lindstrom M. M., Nielsen R. L., and Drake M. J. (1977b) Petrology and geochemistry of lithic fragments separated from the Apollo 15 deep-drill core. *Proc. Lunar Sci. Conf. 8th*, pp. 2869-2888.
- Lindstrom M. M., Knapp S. A., Shervais J. W., and Taylor L. A. (1984) Magnesian anorthosites and associated troctolites and dunite in Apollo 14 breccias. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C41-C49.
- Lindstrom M. M., Lindstrom D. J., Korotev R. L., and Haskin L. A. (1986) Lunar meteorite Yamato-791197: A polymict anorthositic norite breccia. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 58-75. Natl. Inst. for Polar Res., Tokyo.
- Lingenfelter R. E. and Hudson H. S. (1980) Solar particle fluxes and the ancient Sun. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 69-79. Pergamon, New York.
- Lingenfelter R. E., Canfield E. H., and Hess W. N. (1961) The lunar neutron flux. *J. Geophys. Res.*, 66, 2665-2671.
- Lingenfelter R. E., Canfield E. H., and Hampel V. E. (1972) The lunar neutron flux revisited. *Earth Planet. Sci. Lett.*, 16, 355-369.
- Linsky J. L. (1973) The Moon as a proposed radiometric standard for microwave and infrared observations of extended sources: *Astrophys. J. Suppl.* 216, 25, 163-204.
- Lipin B. R. and Muan A. (1974) Equilibria bearing on the behavior of titanate phases during crystallization of iron silicate melts under strongly reducing conditions. *Proc. Lunar Sci. Conf. 5th*, pp. 535-548.
- Lofgren G. E. (1974) An experimental study of plagioclase crystal morphology: Isothermal crystallization. *Am. J. Sci.*, 274, 243-273.
- Lofgren G. E. (1975) Dynamic crystallization experiments on mare basalts (abstract). In *Papers Presented to the Conference on Origins of Mare Basalts and Their Implications for Lunar Evolution*, pp. 99-103. The Lunar Science Institute, Houston.
- Lofgren G. E. (1977) Dynamic crystallization experiments bearing on the origin of textures in impact-generated liquids. *Proc. Lunar Sci. Conf. 8th*, pp. 2079-2095.
- Lofgren G. E. (1980) Experimental studies on the dynamic crystallization of silicate melts. In *Physics of Magmatic Processes* (R. B. Hargraves, ed.), pp. 487-551. Princeton Univ., Princeton, New Jersey.
- Lofgren G. E. (1983) Effect of heterogeneous nucleation on basaltic textures: A dynamic crystallization study. *J. Petrol.*, 24, 229-255.
- Lofgren G. E., Donaldson C. H., Williams R. J., Mullins O. Jr., and Usselman T. M. (1974) Experimentally reproduced textures and mineral chemistry of Apollo 15 quartz normative basalts. *Proc. Lunar Sci. Conf. 5th*, pp. 549-567.
- Lofgren G. E., Donaldson C. H., and Usselman T. M. (1975) Geology, petrology, and crystallization of Apollo 15 quartz-normative basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 79-99.
- Lofgren G. E., Smith D. P., and Brown R. W. (1978) Dynamic crystallization and kinetic melting of the lunar soil. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 959-976.
- Longhi J. (1978) Pyroxene stability and the composition of the lunar magma ocean. *Proc. Lunar Sci. Conf. 9th*, pp. 285-306.
- Longhi J. and Ashwal L. D. (1985) Two-stage models for lunar and terrestrial anorthosites: Petrogenesis without a magma ocean. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C571-0584.
- Longhi J. and Boudreau A. E. (1979) Complex igneous processes and the formation of primitive lunar crustal rocks. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2085-2105.
- Longhi J. and Pan V. (1986) The architecture of the ol-pl-qtz pseudoternary liquidus diagram (abstract). In *Lunar and Planetary Science XVII*, pp. 492-493. Lunar and Planetary Institute, Houston.
- Longhi J., Walker D., and Hays J. F. (1972) Petrography and crystallization history of basalts 14310 and 14072. *Proc. Lunar Sci. Conf. 3rd*, pp. 131-139.
- Longhi J., Walker D., Grove T. L., Stolper E. M., and Hays J. M. (1974) The petrology of the Apollo 17 mare basalts. *Proc. Lunar Sci. Conf. 5th*, pp. 447-469.
- Longhi J., Walker D., and Hays J. F. (1976) Fe, Mg, and silica in lunar plagioclase (abstract). In *Lunar Science VII*, pp. 501-503. The Lunar Science Institute, Houston.
- Longhi J., Walker D., and Hays J. F. (1978) The distribution of Fe and Mg between olivine and lunar basaltic liquids. *Geochim. Cosmochim. Acta*, 42, 1545-1558.
- Lorr D. B., Garshenk V., and Cadoux C., eds. (1989) *Working in Orbit and Beyond: The Challenge of Space Medicine*. Science and Technology Series, Vol. 72 (supplement to *Advances in the Astronautical Sciences*), Univelt, San Diego. 188 pp.
- Lovering J. F. and Hughes T. C. (1971) Rhenium and osmium abundance determinations and meteoritic contamination levels in Apollo 11 and Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1331-1335.

- Lovering J. F. and Ware N. G. (1970) Electron-probe microanalyses of minerals and glasses in Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 633–654.
- Lovering J. F. and Wark D. A. (1971) Uranium-enriched phases in Apollo 11 and Apollo 12 basaltic rocks. *Proc. Lunar Sci. Conf. 2nd*, pp. 151–158.
- Lovering J. F. and Wark D. A. (1975) The lunar crust: Chemically defined rock groups and their K-U fractionation. *Proc. Lunar Sci. Conf. 6th*, pp. 1203–1217.
- Lovering J. F., Wark D. A., Reid A. F., Ware N. G., Keil K., Prinz M., Bunch T. E., El Goresy A., Ramdohr P., Brown G. M., Peckett A., Phillips R., Cameron E. N., Douglas J. A. V., and Plant A. G. (1971) Tranquillityite: A new silicate mineral from Apollo 11 and Apollo 12 basaltic rocks. *Proc. Lunar Sci. Conf. 2nd*, pp. 39–45.
- Low F. J. and Davidson A. W. (1965) Lunar observations at a wavelength of 1 millimeter. *Astrophys. J.*, 142, 1278–1282.
- Low F. J. and Mendell W. W. (1973) Infrared scanning radiometer. In *Apollo 17 Preliminary Science Report*, pp. 24–1 to 24–6. NASA SP-330.
- Lowrance W. W. (1976) *Of Acceptable Risk: Science and the Determination of Safety*. William Kaufmann, Los Altos, California. 180 pp.
- LSPET (Lunar Sample Preliminary Examination Team) (1969) Preliminary examination of lunar samples from Apollo 11. *Science*, 165, 121 1–1227.
- LSPET (Lunar Sample Preliminary Examination Team) (1970) Preliminary examination of lunar samples from Apollo 12. *Science*, 167, 1325–1339.
- LSPET (Lunar Sample Preliminary Examination Team) (1971a) Preliminary examination of lunar samples from Apollo 14. *Science*, 173, 681–693.
- LSPET (Lunar Sample Preliminary Examination Team) (1971b) *Lunar Sample Information Catalog: Apollo 15*. NASA MSC-03209.
- LSPET (Lunar Sample Preliminary Examination Team) (1972) The Apollo 15 lunar samples: A preliminary description. *Science*, 175, 363–375.
- LSPET (Lunar Sample Preliminary Examination Team) (1973a) The Apollo 16 lunar samples: Petrographic and chemical description. *Science*, 179, 23–34.
- LSPET (Lunar Sample Preliminary Examination Team) (1973b) Apollo 17 lunar samples, chemical and petrographic description. *Science*, 182, 659–672.
- Lucchitta B. K. (1976) Mare ridges and related highland scarps—Results of vertical tectonism? *Proc. Lunar Sci. Conf. 7th*, pp. 2761–2782.
- Lucchitta B. K. (1978) Geologic map of the north side of the Moon. *U.S. Geol. Surv. Map 1–1062*.
- Lucchitta B. K. and Watkins J. A. (1978) Age of graben systems on the moon. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3459–3472.
- Lucey P. G. and Hawke B. R. (1988) A remote mineralogical perspective on gabbroic units in the lunar highlands. *Proc. Lunar Planet. Sci. Conf. 18th*, pp. 355–363.
- Lucey P. G., Hawke B. R., Pieters C. M., Head J. W., and McCord T. B. (1986) A compositional study of the Aristarchus region of the Moon using near-infrared reflectance spectroscopy. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D344–D354.
- Lugmair G. W. (1987) The age of the lunar crust: 60025—Methuselah's legacy (abstract). In *Lunar and Planetary Science XVIII*, pp. 584–585. Lunar and Planetary Institute, Houston.
- Lugmair G. W., Marti K., Kurtz J. P., and Scheinin N. B. (1976) History and genesis of lunar troctolite 76535 or: How old is old? *Proc Lunar Sci. Conf. 7th*, pp. 2009–2033.
- Lunar Geoscience Working Group (1986) *Status and Future of Lunar Geoscience* NASA SP-484. 54 pp.
- Lunar Science Institute (1972) *Post Apollo Lunar Science*. Report of a study by The Lunar Science Institute, Houston, Texas, July 1972. 104 pp.
- Lunatic Asylum (1970) Mineralogical and isotopic investigations on lunar rock 12013. *Earth Planet. Sci. Lett.*, 9, 137–163.
- Lynn V. L., Sohigian M. D., and Crocker E. A. (1964) Radar observations of the Moon at a wavelength of 8.6 millimeter. *J. Geophys. Res.*, 69, 781–783.
- Lot B. (1929) Recherches sur la polarisation de la lumière des planètes et de quelques substances terrestres. *Annales de l'Observatoire de Paris, Section de Meudon*, VIII, No. 1. Translated to English in NASA Technical Translation F-187 (1964).
- Ma M.-S. and Schmitt R. A. (1980) Chemistries of lithic fragments from the Apollo 17 drill core sections 70003, 70005, and 70007—III—Anorthosites and chemically unique fragments (abstract). In *Lunar and Planetary Science XI*, pp. 640–642. Lunar and Planetary Institute, Houston.
- Ma M.-S. and Schmitt R. A. (1982) Chemistry of the matrix, the glass coating and an olivine clast from polymict ANT breccia 60035 (abstract). In *Lunar and Planetary Science XIII*, pp. 453–454. Lunar and Planetary Institute, Houston.
- Ma M.-S., Schmitt R. A., Taylor G. J., Warner R. D., Lange D., and Keil K. (1978) Chemistry and petrology of Luna 24 lithic fragments and <250 μm soils: Constraints on the origin of VLT mare basalts. In *Mare Crisium: The View from Luna 24* (J. J. Papike and R. B. Merrill, eds.), pp. 569–592. Pergamon, New York.
- Ma M.-S., Schmitt R. A., Nielsen R. L., Taylor G. J., Warner R. D., and Keil K. (1979) Petrogenesis of Luna 16 aluminous mare basalts. *Geophys. Res. Lett.*, 6, 909–912.
- Ma M.-S., Schmitt R. A., Taylor G. J., Warner R. D., and Keil K. (1981a) Chemical and petrographic study of spinel troctolite in 67435: Implications for the origin of Mg-rich plutonic rocks (abstract). In *Lunar and Planetary Science XI*, pp. 640–642. Lunar and Planetary Institute, Houston.
- Ma M.-S., Liu Y.-G., and Schmitt R. A. (1981b) A chemical study of individual green glasses and brown glasses from 15426: Implications for their petrogenesis. *Proc. Lunar Planet. Sci. 12B*, pp. 915–933.
- MacDonald G. A. (1972) *Volcanoes*. Prentice-Hall, Englewood Cliffs, New Jersey. 510 pp.

- MacDonald G. J. F. (1964) Tidal friction. *Rev. Geophys.*, 2, 467–541.
- MacDougall J. D. and Kothari B. K. (1976) Formation chronology for C2 meteorites. *Earth Planet. Sci. Lett.*, 33, 36–44.
- MacDougall J. D., Rajan R. S., Hutcheon I. D., and Price P. B. (1973) Irradiation history and accretionary processes in lunar and meteoritic breccias. *Proc. Lunar Sci. Conf. 4th*, pp. 2319–2336.
- MacElroy R. D., Klein H. P., and Avern M. M. (1985) The evolution of CELSS for lunar bases. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 623–633. Lunar and Planetary Institute, Houston.
- Mackin J. H. (1969) Origin of the lunar maria. *Geol. Soc. Am. Bull.*, 80, 735–748.
- Mahmood A., Mitchell J. K., and Carrier W. D. III (1974a) Grain orientation in lunar soil. *Proc. Lunar Sci. Conf. 5th*, pp. 2347–2354.
- Mahmood A., Mitchell J. K., and Carrier W. D. III (1974b) Particle shapes of three lunar soil samples. Unpublished report, available from W. D. Carrier III.
- Malvin D. J. and Drake M. J. (1987) Experimental determination of crystal/melt partitioning of Ga and Ge in the system forsterite-anorthite-diopside. *Geochim. Cosmochim. Acta*, 51, 2117–2128.
- Manka R. H. and Michel F. C. (1971) Lunar atmosphere as a source of lunar surface elements. *Proc. Lunar Sci. Conf. 2nd*, pp. 1717–1728.
- Mantel E. J. and Miller E. R., eds. (1977) *Catalog of Lunar Mission Data*. National Space Science Data Center, World Data Center A for Rockets and Satellites, Goddard Space Flight Center, Greenbelt, MD. 204 pp.
- Mark R. K., Lee-Hu C.-N., and Wetherill G. W. (1974) Rb-Sr age of lunar igneous rocks 62295 and 14310. *Geochim. Cosmochim. Acta*, 38, 1643–1648.
- Marsh S. P. (1980) *LASL Shock Hugoniot Data*. Univ. of California, Berkeley. 658 pp.
- Marti K., Lugmair G. W., and Urey H. C. (1970) Solar wind gases, cosmic-ray spallation products and the irradiation history of Apollo 11 samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1357–1367.
- Marti K., Aeschlimann U., Eberhardt P., Geiss J., Grögler N., Jost D. T., Laul J. C., Ma M.-S., Schmitt R. A., and Taylor G. J. (1983) Pieces of the ancient lunar crust: Ages and composition of clasts in consortium breccia 67915. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B165–B175.
- Martin R. T., Winkler J. L., Johnson S. W., and Carrier W. D. III (1973) Measurement of conductance of Apollo 12 lunar simulants taken in the molecular flow range for helium, argon, and krypton gases. Unpublished report.
- Marvin U. B. (1971) Lunar niobian rutile. *Earth Planet. Sci. Lett.*, 11, 7–9.
- Marvin U. B. and Lindstrom M. M. (1983) Rock 67015: A feldspathic fragmental breccia with KREEP-rich melt clasts. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A659–A670.
- Marvin U. B. and Walker D. (1978) Implications of a titanium-rich glass clod at Oceanus Procellarum. *Am. Mineral.*, 63, 924–929.
- Marvin U. B. and Walker D. (1985) A transient heating event in the history of a highlands troctolite from Apollo 12 soil 12033. *Proc. Lunar Sci. Conf. 15th*, in *J. Geophys. Res.*, 90, C421–C429.
- Marvin U. B. and Warren P. H. (1980) A pristine eucritlike gabbro from Descartes and its exotic kindred. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 507–521.
- Marvin U. B., Wood J. A., Taylor G. J., Reid J. B. Jr., Powell B. N., Dickey J. S. Jr., and Bower J. F. (1971) Relative proportion and probable sources of rock fragments in the Apollo 12 soil samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 679–699.
- Marvin U. B., Lindstrom M. M., Bernatowicz T. J., Podosek F. A., and Sugiura N. (1987) The composition and history of breccia 67015 from North Ray Crater. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 90 E4 71–E490.
- Masaytis V. L., Mikhailov M. V., and Selivanovskaya T. V. (1975) *The Popigay Meteorite Crater*. Nauka, Moscow. 124 pp.
- Mason B. (1971) *Handbook of Elemental Abundances in Meteorites*. Gordon and Breach, New York. 566 pp.
- Mason B. (1979) *Cosmochemistry, Part 1: Meteorites*. U.S. Geol. Surv. Prof. Pap. 440B-1.
- Mason B., Simkin T., Norman A. F., Switzer G. S., Nelen J. A., Thompson G., and Melson W. G. (1973) Composition of Apollo 16 fines 60051, 60052, 64811, 67711, 67712, 68821 and 68822 (abstract). In *Lunar Science IV*, pp. 505–507. The Lunar Science Institute, Houston.
- Mason R. J., Guest J. E., and Cooke G. N. (1976) An Imbrium pattern of graben on the moon. *Proc. Geol. Assoc. London*, 87, pp. 161–168.
- Masuda A., Nakamura N., Kurasawa H., and Tanaka T. (1972) Precise determination of rare-earth elements in the Apollo 14 and 15 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1307–1315.
- Masuda A., Nakamura N., and Tanaka T. (1973) Fine structures of mutually normalized rare-earth patterns of chondrites. *Geochim. Cosmochim. Acta*, 37, 239–248.
- Masuda A., Tanaka T., Nakamura N., and Kurasawa H. (1974) Possible REE anomalies of Apollo 17 REE patterns. *Proc. Lunar Sci. Conf. 5th*, pp. 1247–1253.
- Masursky H. (1964) A preliminary report on the role of isostatic rebound in the geological development of the lunar crater Ptolemaeus. In *Astrogeological Studies*, pp. 102–134. U.S. Geol. Surv. Open File Annu. Prog. Rpt., Part A. 134 pp.
- Masursky H., Colton G. W., and El-Baz F. (1978) *Apollo Over the Moon: A View from Orbit* NASA SP-362. 255 pp.
- Matsui T., Waza T., Kani K., and Suzuki S. (1982) Laboratory simulation of planetesimal collision. *J. Geophys. Res.*, 87, 10968–10982.
- Maxwell D. E. (1977) Simple Z model of cratering, ejection and the overturned flap. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 1003–1008. Pergamon, New York.

- Maxwell J. A., Peck L. C., and Wiik H. B. (1970) Chemical composition of Apollo 11 lunar samples 10017, 10020, 10072, and 10084. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1369–1374.
- Maxwell T. A. (1978) Origin of multi-ring basin ridge systems: An upper limit to elastic deformation based on a finite-element model. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3541–3559.
- Maxwell T. A., El-Baz F., and Ward S. H. (1975) Distribution, morphology, and origin of ridges and arches in Mare Serenitatis. *Geol. Soc. Am. Bull.*, 86, 1273–1278.
- May T. W. (1976) Holographic analysis and interpretation of the 5 megahertz radar imagery of the Apollo Lunar Sounder experiment in Maria Serenitatis and Crisium. M.Sc. thesis, Univ. of Utah. 91 pp.
- McCallister R. H. and Taylor L. A. (1973) Kinetics of ulvöspinel reduction—synthetic study and applications to lunar rocks. *Earth Planet. Sci. Lett.*, 17, 357–364.
- McCallum I. S. and Mathez E. A. (1975) Petrology of noritic cumulates and a partial melting model for the genesis of Fra Mauro basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 395–414.
- McCallum I. S., Mathez E. A., Okamura F. P., and Ghose S. (1974) Petrology and crystal chemistry of poikilitic anorthositic gabbro 77017. *Proc. Lunar Sci. Conf. 5th*, pp. 287–302.
- McCauley J. F. (1967) Geologic map of the Hevelius region of the Moon. *U.S. Geol. Surv. Misc. Inv. Map I-491*.
- McCauley J. F. and Scott D. H. (1972) The geologic setting of the Luna 16 landing site. *Earth Planet. Sci. Lett.*, 13, 225–232.
- McCord T. B. and Adams J. B. (1973) Progress in remote optical analysis of lunar surface composition. *The Moon*, 7, 453–474.
- McCord T. B., Charette M. P., Johnson T. V., Lebofsky L. A., Pieters C., and Adams J. B. (1972a) Lunar spectral types. *J. Geophys. Res.*, 77, 1349–1359.
- McCord T. B., Charette M. P., Johnson T. V., Lebofsky L. A., and Pieters C. (1972b) Spectrophotometry (0.3 to 1.1 μm) of visited and proposed Apollo lunar landing sites. *The Moon*, 5, 52–89.
- McCord T. B., Pieters C. M., and Feierberg M. A. (1976) Multi-spectral mapping of the lunar surface using groundbased telescopes. *Icarus*, 29, 1–34.
- McCord T. B., Grabow M., Feierberg M. A., MacLaskey D., and Pieters C. M. (1979) Lunar multispectral maps: Part H of the lunar nearside. *Icarus*, 37, 1–28.
- McCord T. B., Clark R. N., Hawke B. R., McFadden L. A., Owensby P. D., Pieters C. M., and Adams J. B. (1981) Moon: Near-infrared spectral reflectance, a first good look. *J. Geophys. Res.*, 86, 10883–10892.
- McCoy J. E. (1976a) Additional photometric studies of light scattering above the lunar terminator from Apollo orbital corona photography (abstract). In *Lunar Science VII*, pp. 515–517. The Lunar Science Institute, Houston.
- McCoy J. E. (1976b) Astronaut observations (abstract). In *Abstracts for Special Symposium on Recent Activity in the Moon, Supplement to Lunar Science VII*, pp. 11–13. The Lunar Science Institute, Houston.
- McCoy J. E. and Criswell D. R. (1974a) Additional astronaut observations of possible light scattering by lunar dust atmosphere. In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), pp. 105–106. The Lunar Science Institute, Houston.
- McCoy J. E. and Criswell D. R. (1974b) Evidence for a high altitude distribution of lunar dust. *Proc. Lunar Sci. Conf. 5th*, pp. 2991–3005.
- McDonnell J. A. M. (1977) The role of accretionary particles on lunar exposure and aging processes—lunar dust slows lunar clocks. *COSPAR Plenary Meeting 20th*, p. 6. Tel Aviv, Israel.
- McDonnell J. A. M., ed. (1978) *Cosmic Dust* Wiley, New York. 693 pp.
- McDonnell J. A. M. (1979) Lunar surface grain motion: Electrostatic charging, supercharging (electret effects) and mechanical bonding. In *COSPAR Space Research XIX*, pp. 455–458. Pergamon, New York.
- McDonnell J. A. M. and Flavill R. P. (1977) Lunar surface microscale transportation phenomena: I. In *COSPAR Space Research XVII*, pp. 611–616. Pergamon, New York.
- McGetchin T. R. and Head J. W. (1973) Lunar cinder cones. *Science*, 180, 68–71.
- McGetchin T. R., Settle M., and Head J. W. (1973) Radial thickness variation in crater ejecta: Implications for lunar basin models. *Earth Planet. Sci. Lett.*, 20, 226–236.
- McGetchin T. R., Settle M., and Head J. W. (1973) Radial thickness variation in crater ejecta: Implications for lunar basin models. *Earth Planet. Sci. Lett.*, 20, 226–236.
- McGuire R. E. and von Rosenvinge T. T. (1984) The energy spectra of solar energetic particles. *Adv. Space Res.*, 4, 117–125.
- McGuire R. E., von Rosenvinge T. T., and McDonald F. B. (1986) The composition of solar energetic particles. *Astrophys. J.*, 301, 938–961.
- McKay D. S. and Basu A. (1983) The production curve for agglutinates in planetary regoliths. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B193–B199.
- McKay D. S. and Williams R. J. (1979) A geologic assessment of potential lunar ores. In *Space Resources and Space Settlements* (J. Billingham et al., eds.), pp. 243–256. NASA SP-428.
- McKay D. S., Greenwood W. R., and Morrison D. A. (1970) Origin of small lunar particles and breccia from the Apollo 11 site. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 673–694.
- McKay D. S., Heiken G. H., Taylor R. M., Clanton U. S., Morrison D. A., and Ladle G. H. (1972) Apollo 14 soils: Size distribution and particle types. *Proc. Lunar Sci. Conf. 3rd*, pp. 983–995.
- McKay D. S., Clanton U. S., and Ladle G. (1973) Scanning electron microscope study of Apollo 15 green glass. *Proc. Lunar Sci. Conf. 4th*, pp. 225–238.
- McKay D. S., Fruland R. M., and Heiken G. H. (1974) Grain size and evolution of lunar soils. *Proc. Lunar Sci. Conf. 5th*, pp. 887–906.

- McKay D. S., Dungan M. A., Morris R. V., and Fruland R. M. (1977) Grain size, petrographic, and FMR studies of the double core 60009/10: A study of soil evolution. *Proc. Lunar Sci. Conf. 8th*, pp. 2929–2952.
- McKay D. S., Heiken G. H., and Waits G. (1978a) Core 74001/2: Grain size and petrology as a key to the rate of *in-situ* reworking and lateral transport on the lunar surfaces. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1913–1932.
- McKay D. S., Basu A., and Waits G. (1978b) Grain size and the evolution of Luna 24 soils. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 125–136. Pergamon, New York.
- McKay D. S., Basu A., and Nace G. (1980) Lunar core 15010/11: Grain size, petrology, and implications for regolith dynamics. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1531–1550.
- McKay D. S., Bogard D. D., Morris R. V., Korotev R. L., Johnson D., and Wentworth S. J. (1986) Apollo 16 regolith breccias: Characterization and evidence for early formation in the mega-regolith. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D277–D303.
- McKay G. A. and Weill D. F. (1976) Petrogenesis of KREEP. *Proc. Lunar Sci. Conf. 7th*, pp. 2427–2447.
- McKay G. A. and Weill D. F. (1977) KREEP petrogenesis revisited. *Proc. Lunar Sci. Conf. 8th*, pp. 2339–2335.
- McKay G. A., Wiesmann H., Bansal B. M., and Shih C.-Y. (1979) Petrology, chemistry, and chronology of Apollo 14 KREEP basalts. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 181–205.
- McKinley J. P., Taylor G. J., Keil K., Ma M.-S., and Schmitt R. A. (1984) Apollo 16: Impact melt sheets, contrasting nature of the Cayley Plains and Descartes Mountains, and geologic history. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 89, pp. B513–B524.
- McSween H. Y. Jr. (1985) SNC meteorites: Clues to martian petrologic evolution? *Rev. Geophys.*, 23, 391–416.
- Mehta S. and Goldstein J. I. (1979) Analytical electron microscopy study of submicroscopic metal particles in glassy constituents of lunar breccias 15015 and 60095. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1507–1521.
- Mehta S., Goldstein J. I., and Friel J. J. (1979) Investigations of submicron sized metal particles in glass coatings of lunar breccia 15286. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1523–1530.
- Melosh H. J. (1975) Large impact craters and the Moon's orientation. *Earth Planet. Sci. Lett.*, 26, 353–360.
- Melosh H. J. (1977) Crater modification by gravity: A mechanical analysis of slumping. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 1245–1260. Pergamon, New York.
- Melosh H. J. (1978) The tectonics of mascon loading. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3513–3525.
- Melosh H. J. (1982) A schematic model of crater modification by gravity. *J. Geophys. Res.*, 87, 371–380.
- Mendell W. W. (1976) Degradation of large, period II craters. *Proc. Lunar Sci. Conf. 7th*, pp. 2705–2716.
- Mendell W. W., ed. (1985) *Lunar Bases and Space Activities of the 21st Century*. Lunar and Planetary Institute, Houston. 865 pp.
- Mendell W. W. and Low F. J. (1975) Infrared orbital mapping of lunar features. *Proc. Lunar Sci. Conf. 6th*, pp. 2711–2719.
- Mendell W. W. and McKay D. S. (1975) A lunar soil evolution model. *The Moon*, 13, 285–292.
- Merlivat L., Lelu M., Nief G., and Roth E. (1974) Deuterium, hydrogen, and water content of lunar material. *Proc. Lunar Sci. Conf. 5th*, pp. 1885–1895.
- Metzger A. E. and Parker R. E. (1979) The distribution of titanium on the lunar surface. *Earth Planet. Sci. Lett.*, 45, 155–171.
- Metzger A. E., Trombka J. I., Peterson L. E., Reedy D. C., and Arnold J. R. (1973) Lunar surface radioactivity: Preliminary results of the Apollo 15 and Apollo 16 gamma-ray spectrometer experiments. *Science*, 179, 800–803.
- Metzger A. E., Haines E. L., Parker R. E., and Radocinski R. G. (1977) Thorium concentrations in the lunar surface. I: Regional values and crustal content. *Proc. Lunar Sci. Conf. 8th*, pp. 949–999.
- Meyer C. (1978) Ion microprobe analyses of aluminous lunar glasses: A test of the "rock type" hypothesis. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1551–1570.
- Meyer C. Jr. and Schonfeld E. (1977) Ion microprobe study of glass particles from lunar sample 15101 (abstract). In *Lunar Science VIII*, pp. 661–663. The Lunar Science Institute, Houston.
- Meyer C. Jr., McKay D. S., Anderson D. H., and Butler P. Jr. (1975) The source of sublimates on the Apollo 15 green and Apollo 17 orange glass samples. *Proc. Lunar Sci. Conf. 6th*, pp. 1673–1699.
- Meyer H. O. A. and Boctor N. Z. (1974) Opaque mineralogy: Apollo 17 rock 75035. *Proc. Lunar Sci. Conf. 5th*, pp. 707–716.
- Meyer H. O. A. and McCallister R. H. (1977) The Apollo 16 deep drill core. *Proc. Lunar Sci. Conf. 8th*, pp. 2889–2907.
- Michel R., Herpers U., Kulus H., and Herr W. (1972) Isotopic anomalies in lunar rhenium. *Proc. Lunar Sci. Conf. 3rd*, pp. 1917–1925.
- Middlehurst B. M. (1977) A survey of lunar transient phenomena. *Phys. Earth Planet. Inter.*, 14, 185–193.
- Miller M. D., Pacer R. A., Ma M.-S., Hawke B. R., Lookhart G. L., and Ehmann W. D. (1974) Compositional studies of the lunar regolith at the Apollo 17 site. *Proc. Lunar Sci. Conf. 5th*, pp. 1079–1086.
- Minkin J. A., Thompson C. L., and Chao E. C. T. (1977) Apollo 16 white boulders consortium samples 67455 and 67475: Petrologic investigation. *Proc. Lunar Sci. Conf. 8th*, pp. 1967–1986.
- Minnaert M. (1961) Photometry of the Moon. In *The Solar System, Vol. III: Planets and Satellites* (G. Kuiper and B. Middlehurst, eds.), pp. 213–248. Univ. of Chicago, Chicago. 601 pp.
- Misra K. C. and Taylor L. A. (1975a) Characteristics of metal particles in Apollo 16 rocks. *Proc. Lunar Sci. Conf. 6th*, pp. 615–639.

- Misra K. C. and Taylor L. A. (1975b) Correlation between native metal compositions and the petrology of Apollo 16 rocks (abstract). In *Lunar Science VI*, pp. 566–568. The Lunar Science Institute, Houston.
- Mitchell J. K. (1976) *Fundamentals of Soil Behavior*. Wiley, New York. 422 pp.
- Mitchell J. K. and Durgunoglu H. T. (1973) *In-situ* strength by static cone penetration test. *Proc. Intl. Conf. on Soil Mech. and Found. Eng., Vol. 1*, pp. 279–286.
- Mitchell J. K. and Houston W. N. (1974) Static penetration testing on the Moon. *European Symposium in Penetration Testing 1st*, pp. 277–284. Intl. Soc. for Soil Mech. and Found. Eng.
- Mitchell J. K., Bromwell L. G., Carrier W. D. III, Costes N. C., and Scott R. F. (1971) Soil mechanics experiment. In *Apollo 14 Preliminary Science Report*, pp. 87–108. NASA SP-272.
- Mitchell J. K., Bromwell L. G., Carrier W. D. III, Costes N. C., Houston W. N., and Scott R. F. (1972a) Soil-mechanics experiments. In *Apollo 15 Preliminary Science Report*, pp. 7–1 to 7–28. NASA SP-289.
- Mitchell J. K., Carrier W. D. III, Houston W. N., Scott R. F., Bromwell L. G., Durgunoglu H. T., Hovland H. J., Treadwell D. D., and Costes N. C. (1972b) Soil mechanics. In *Apollo 16 Preliminary Science Report*, pp. 8–1 to 8–29. NASA SP-315.
- Mitchell J. K., Bromwell L. G., Carrier W. D. III, Costes N. C., and Scott R. F. (1972c) Soil mechanical properties at the Apollo 14 site. *J. Geophys. Res.*, 77, 5641–5664.
- Mitchell J. K., Houston W. N., Scott R. F., Costes N. C., Carrier W. D. III, and Bromwell L. G. (1972d) Mechanical properties of lunar soil: Density, porosity, cohesion, and angle of friction. *Proc. Lunar Sci. Conf. 3rd*, pp. 3235–3253.
- Mitchell J. K., Carrier W. D. III, Costes N. C., Houston W. N., Scott R. F., and Hovland H. J. (1973a) Soil mechanics. In *Apollo 17 Preliminary Science Report*, pp. 8–1 to 8–22. NASA SP-330.
- Mitchell J. K., Carrier W. D. III, Costes N. C., Houston W. N., and Scott R. F. (1973b) Surface soil variability and stratigraphy at the Apollo 16 site. *Proc. Lunar Sci. Conf. 4th*, pp. 2437–2445.
- Mitchell J. K., Houston W. N., Carrier W. D. III, and Costes N. C. (1974) *Apollo Soil Mechanics Experiment S-200*. Final report, NASA Contract NAS 9–11266, Space Sciences Laboratory Series 15, Issue 7, Univ. of California, Berkeley.
- Moore C. B. and Lewis C. F. (1976) Total nitrogen contents of Apollo 15, 16, and 17 lunar rocks and breccias (abstract). In *Lunar Science VII*, pp. 571–573. The Lunar Science Institute, Houston.
- Moore C. B., Lewis C. F., Larimer J. W., Delles F. M., Gooley R., and Nichiporuk W. (1971) Total carbon and nitrogen abundances in Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1343–1350.
- Moore C. B., Lewis C. F., Cripe J., Delles F. M., Kelly W. R., and Gibson E. K. Jr. (1972) Total carbon, nitrogen, and sulfur in Apollo 14 lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 2051–2058.
- Moore C. B., Lewis C. F., and Gibson E. K. Jr. (1973) Total carbon contents of Apollo 15 and 16 lunar samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1613–1623.
- Moore C. B., Lewis C. F., and Cripe J. D. (1974) Total carbon and sulfur contents of Apollo 17 lunar samples. *Proc. Lunar Sci. Conf. 5th*, pp. 1897–1906.
- Moore H. J. (1970) *Estimates of the Mechanical Properties of Lunar Surface Using Tracks and Secondary Craters Produced by Blocks and Boulders*. U.S. Geol. Surv. Interagency Report, Astrogeology, 22.
- Moore H. J. (1972) Large blocks around lunar craters. In *Analysis of Apollo 10 Photography and Visual Observations*, p. 26. NASA SP-232 (1971).
- Moore H. J., Hodges C. A., and Scott D. H. (1974) Multiringed basins—illustrated by Orientale and associated features. *Proc. Lunar Sci. Conf. 5th*, pp. 71–100.
- Moore R. K. (1983) Radar fundamentals and scatterometers. In *Manual of Remote Sensing Vol. 1*, 2nd edition (R. N. Colwell, ed.), pp. 369–428. American Society of Photogrammetry, Falls Church, Virginia.
- Morgan J. W. and Petrie R. K. (1979) Breccias 73215 and 73255: Siderophile and volatile trace elements. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 789–801.
- Morgan J. W. and Wandless G. A. (1979) 74001 drive tube: Siderophile elements match IIB iron meteorite pattern. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 327–340.
- Morgan J. W. and Wandless G. A. (1984) Surface-correlated trace elements in 15426 lunar glass (abstract). In *Lunar and Planetary Science XV*, pp. 562–563. Lunar and Planetary Institute, Houston.
- Morgan J. W., Krähenbühl U., Ganapathy R., and Anders E. (1972a) Trace elements in Apollo 15 samples: Implications for meteorite influx and volatile depletion on the Moon. *Proc. Lunar Sci. Conf. 3rd*, pp. 1361–1376.
- Morgan J. W., Laul J. C., Krähenbühl U., Ganapathy R., and Anders E. (1972b) Major impacts on the Moon: Characterization from trace elements in Apollo 12 and 14 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1377–1395.
- Morgan J. W., Krähenbühl U., Ganapathy R., Anders E., and Marvin U. (1973) Trace element abundances and petrology of separates from Apollo 15 soils. *Proc. Lunar Sci. Conf. 4th*, pp. 1379–1398.
- Morgan J. W., Ganapathy R., Higuchi H., Krähenbühl U., and Anders E. (1974) Lunar basins: Tentative characterization of projectiles from meteoritic elements in Apollo 17 boulders. *Proc. Lunar Sci. Conf. 5th*, pp. 1703–1736.
- Morgan J. W., Higuchi H., and Anders E. (1975) Meteoritic material in a boulder from the Apollo 17 site: Implications for its origin. *The Moon*, 14, 373–383.
- Morgan J. W., Higuchi H., Takahashi H., and Hertogen J. (1978) A “chondritic” eucrite parent body: Inference from trace elements. *Geochim. Cosmochim. Acta*, 42, 27–38.
- Morris R. V. (1976) Surface exposure indices of lunar rocks: A comparative FMR study. *Proc. Lunar Sci. Conf. 7th*, pp. 315–335.
- Morris R. V. (1977) Origin and evolution of the grain-size dependence of the concentration of fine-grained metal

- in lunar soils: The maturation of lunar soils to a steady-state stage. *Proc. Lunar Sci. Conf. 8th*, pp. 3719–3747.
- Morris R. V. (1978a) In situ reworking (gardening) of the lunar surface: Evidence from the Apollo cores. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1801–1811.
- Morris R. V. (1978b) The surface exposure (maturity) of lunar soils; some concepts and I_s/FeO compilation. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2287–2297.
- Morris R. V. (1980) Origins and size distribution of metallic iron particles in the lunar regolith. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1697–1712.
- Morris R. V. (1985) Determination of optical penetration depths from reflectance and transmittance measurements on albite powders (abstract). In *Lunar and Planetary Science XVI*, pp. 581–582. Lunar and Planetary Institute, Houston.
- Morris R. V. and Gose W. A. (1976) Ferromagnetic resonance and magnetic studies of cores 60009/10 and 60003: Compositional and surface-exposure stratigraphy. *Proc. Lunar Sci. Conf. 7th*, pp. 1–11.
- Morris R. V., Lauer H. V. Jr., and Gose W. A. (1979) Characterization and depositional and evolutionary history of the Apollo 17 deep drill core. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1141–1157.
- Morris R. V., Score R., Dardano C., and Heiken G. (1983) *Handbook of Lunar Soils*. JSC Publ. No. 19069, Planetary Materials Branch Publ. 67. NASA Johnson Space Center, Houston. 914 pp.
- Morris R. V., See T. H., and Hörz F. (1986) Composition of the Cayley Formation at Apollo 16 as inferred from impact melt splashes. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E21–E42.
- Morrison D. A. and Clanton U. S. (1979) Properties of microcraters and cosmic dust of less than 1000 Å dimensions. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1649–1663.
- Morrison G. H., Gerard J. T., Kashuba A. T., Gangadharam E. V., Rothenberg A. M., Potter N. M., and Miller G. B. (1970) Elemental abundances in lunar soil and rock. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1383–1392.
- Morrison G. H., Gerard J. T., Potter N. M., Gangadharam E. V., Rothenberg A. M., and Burdo R. A. (1971) Elemental abundances of lunar soil and rocks from Apollo 12. *Proc. Lunar Sci. Conf. 2nd*, pp. 1169–1185.
- Morrison G. H., Nadkarni R. A., Jaworski J., Botto R. I., and Roth J. R. (1973) Elemental abundances of Apollo 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1399–1405.
- Morrison R. H. and Oberbeck V. R. (1975) Geomorphology of crater and basin deposits — emplacement of the Fra Mauro Formation. *Proc. Lunar Sci. Conf. 6th*, pp. 2503–2530.
- Morrison R. H. and Oberbeck V. R. (1978) A composition and thickness model for lunar impact crater and basin deposits. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3763–3785.
- Muehlberger W. R. (1974) Structural history of southeastern Mare Serenitatis and adjacent highlands. *Proc. Lunar Sci. Conf. 5th*, pp. 101–110.
- Muehlberger W. R., Batson R. M., Boudette E. L., Duke C. M., Eggleton R. E., Elston D. P., England A. W., Freeman V. L., Hait M. H., Hall T. A., Head J. W., Hodges C. A., Holt H. E., Jackson E. D., Jordan J. A., Larson K. B., Milton D. J., Reed V. S., Rennilson J. J., Schaber G. G., Schafer J. P., Silver L. T., Stuart-Alexander D., Sutton R. L., Swann G. A., Tyner R. L., Ulrich G. E., Wilshire H. G., Wolfe E. W., and Young J. W. (1972) Preliminary geologic investigation of the Apollo 16 landing site. In *Apollo 16 Preliminary Science Report*, pp. 6–1 to 6–81. NASA SP-315.
- Muehlberger W. R., Batson R. M., Cernan E. A., Freeman V. L., Hait M. H., Holt H. E., Howard K. A., Jackson E. D., Larson K. B., Reed V. S., Rennilson J. J., Schmitt H. H., Scott D. H., Sutton R. L., Stuart-Alexander D., Swann G. A., Trask N. J., Ulrich G. E., Wilshire H. G., and Wolfe E. W. (1973) Preliminary geologic investigation of the Apollo 17 landing site. In *Apollo 17 Preliminary Science Report*, pp. 6–1 to 6–91. NASA SP-330.
- Muhleman D. O. (1964) Radar scattering from Venus and the Moon. *Astron. J.*, 69, 34–41.
- Muhleman D. O. (1972) Microwave emission from the Moon. In *Thermal Characteristics of the Moon*, Vol. 28 (J. Lucas, ed.), pp. 51–81. MIT, Cambridge.
- Muhleman D. O., Brown W. E. Jr., and Davids L. (1968a) Radar reflectivity analysis, lunar surface electromagnetic properties, part I. In *Surveyor 7 Preliminary Report*, pp. 181–186. NASA SP-173.
- Muhleman D. O., Brown W. E. Jr., and Davids L. (1968b) Lunar surface electromagnetic properties: Radar reflectivity analysis. In *Surveyor 7 Mission Report, Part 2: Science Results*, pp. 209–220. JPL Tech. Rpt. 32–1264, Jet Propulsion Laboratory, Pasadena.
- Muhleman D. O., Brown W. E. Jr., Davids L., Negus de Wys J., and Peake W. H. (1969) Lunar surface electromagnetic properties. In *Surveyor Program Results*, pp. 203–269. NASA SP-184.
- Mukherjee N. R. (1975) Solar-wind interactions: Nature and composition of the lunar atmosphere. *The Moon*, 14, 169–186.
- Müller G. (1967) *Methods in Sedimentary Petrology*, pp. 100–101. Hafner, New York.
- Müller O. (1972) Chemically bound nitrogen abundances in lunar samples, and active gases released by heating at lower temperatures (250–500°C). *Proc. Lunar Sci. Conf. 3rd*, pp. 2059–2068.
- Müller O. (1973) Chemically bound nitrogen contents of Apollo 16 and Apollo 15 lunar fines. *Proc. Lunar Sci. Conf. 4th*, pp. 1625–1634.
- Müller O. (1974) Solar wind nitrogen and indigenous nitrogen in Apollo 17 lunar samples. *Proc. Lunar Sci. Conf. 5th*, pp. 1907–1918.
- Müller P. M. and Sjogren W. L. (1968) Mascons: Lunar mass concentrations. *Science*, 161, 680–684.
- Müller P. M. and Sjogren W. L. (1969) Lunar gravimetry and mascons. *Appl. Mech. Rev.*, 22, 955–959.
- Murali A. V., Ma M.-S., and Schmitt R. A. (1977) Chemistry of 30 Apollo 17 rake basalts; 71597 a product of partial

- olivine accumulation (abstract). In *Lunar Science VIII*, pp. 703–705. The Lunar Science Institute, Houston.
- Murali A. V., Pawaskar P. B., and Reedy G. R. (1979) Chemical studies of two Luna-24 regolith samples. In *Advances in Lunar Research: Luna 24 Samples* (S. K. Trehan and H. Y. Mohan Ram, eds.), pp. 49–58. Indian Natl. Sci. Acad., New Dehli.
- Murali A. V., Zolensky M. E., and Blanchard D. P. (1987) Tektite-like bodies at Lona Crater, India: Implications for the origin of tektites. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E729–E735.
- Murase T. and McBirney A. R. (1970) Viscosity of lunar lavas. *Science*, 167, 1491–1493.
- Murray B. C., Belton M. J. S., Danielson G. E., Davies M. E., Hapke B., O'Leary B. T., Strom R. G., Suomvi V. E., and Trask N. J. (1974) Preliminary description and interpretation from Mariner 10 pictures. *Science*, 185, 169–179.
- Murray J. B. (1980) Oscillating peak model of basin and crater formation. *Moon and Planets*, 22, 269–291.
- Murthy V. R., Evensen N. M., Jahn B.-M., and Coscio M. R. Jr. (1972) Apollo 14 and 15 samples: Rb-Sr ages, trace elements, and lunar evolution. *Proc. Lunar Sci. Conf. 3rd*, pp. 1503–1514.
- Mustard J. F. and Pieters C. M. (1987) Quantitative abundance estimates from bidirectional reflectance measurements. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E617–E626.
- Mutch T. A. (1970) *Geology of the Moon—A Stratigraphic View*. Princeton Univ., Princeton, New Jersey. 324 pp.
- Nagasawa H., Schreiber H. D., and Blanchard D. P. (1976) Partition coefficients of REE and Sc in perovskite, melilite, and spinel and their implications for Allende inclusions (abstract). In *Lunar Science VII*, pp. 588–590. The Lunar Science Institute, Houston.
- Nakamura N. (1974) Determination of REE, Ba, Fe, Mg, Na and K in carbonaceous and ordinary chondrites. *Geochim. Cosmochim. Acta*, 38, 757–775.
- Nakamura N., Unruh D. M., and Tatsumoto M. (1986) REE, Rb-Sr, and Pb isotopic characteristics of the Yamato-791197 meteorite: Evidence for a lunar highland origin. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 106–115. Natl. Inst. for Polar Res., Japan.
- Nakamura Y. (1978) A₁ moonquakes: Source distribution and mechanism. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3589–3607.
- Nakamura Y. (1980) Shallow moonquakes: How they compare with earthquakes. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1847–1853.
- Nakamura Y., Latham G. V., and Dorman H. J. (1982) Apollo lunar seismic experiment—final summary. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A117–A123.
- Naney M. T., Crowl D. M., and Papike J. J. (1976) The Apollo 16 drill core: Statistical analysis of glass chemistry and the characterization of a high alumina-silica poor (HASP) glass. *Proc. Lunar Sci. Conf. 7th*, pp. 155–184.
- NASA (1969) *Analysis of Apollo 8 Photography and Observations*. NASA SP-201. 337 pp.
- NASA Advisory Council (1986) *The Crisis in Space and Earth Science: A Time for New Commitment*. Report by the Space and Earth Science Advisory Committee of the NASA Advisory Council, Washington, DC, November 1986. 84 pp.
- NASA Manned Spacecraft Center (1970) *Apollo 12 Preliminary Science Report*. NASA SP-235. 227 pp.
- Nash W. P. and Hansel W. D. (1973) Partial pressures of oxygen, phosphorus and fluorine in some lunar lavas. *Earth Planet. Sci. Lett.*, 20, 13–27.
- National Commission on Space (1986) *Pioneering the Space Frontier*. Bantam, New York. 211 pp.
- Nava D. F. (1974) Chemistry of some rock types and soils from the Apollo 15, 16 and 17 lunar sites (abstract). In *Lunar Science V*, pp. 547–549. The Lunar Science Institute, Houston.
- Nava D. F. and Philpotts J. A. (1973) A lunar differentiation model in light of new chemical data on Luna 20 and Apollo 16 soils. *Geochim. Cosmochim. Acta*, 37, 963–973.
- Nava D. F., Lindstrom M. M., Schuhmann P. J., Lindstrom D. J., and Philpotts J. A. (1976) The remarkable chemical uniformity of Apollo 16 layered deep drill core section 60002. *Proc. Lunar Sci. Conf. 7th*, pp. 133–139.
- Nava D. F., Winzer S. R., Lindstrom D. J., Meyerhoff M., Lum R. K. L., Schuhmann P. J., Lindstrom M. M., and Philpotts J. A. (1977) Rind glass and breccia: A study of lunar sample 15255 (abstract). In *Lunar Science VIII*, pp. 720–722. The Lunar Science Institute, Houston.
- Nehru C. E., Prinz M., Dowty E., and Keil K. (1974) Spinel-group minerals and ilmenite in Apollo 15 rock samples. *Am. Mineral.*, 59, 1220–1234.
- Nehru C. E., Warner R. D., and Keil K. (1976) *Electron Microprobe Analyses of Opaque Mineral Phases from Apollo 11 Basalts*. Univ. of New Mexico Spec. Publ. 17, Albuquerque.
- Neukum G. (1977) Different ages for lunar light plains. *The Moon*, 17, 383–393.
- Neukum G. and Wise D. U. (1976) Mars: A standard crater curve and possible new time scale. *Science*, 194, 1381–1387.
- Neukum G., Konig B., Fechtig H., and Storzer D. (1975) Cratering in the Earth-Moon system: Consequences for age determinations by crater counting. *Proc. Lunar Sci. Conf. 6th*, pp. 2597–2620.
- Newsom H. E. (1986) Constraints on the origin of the Moon from the abundance of molybdenum and other siderophile elements. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds.), pp. 203–229. Lunar and Planetary Institute, Houston.
- Newton R. C., Anderson A. T., and Smith J. V. (1971) Accumulation of olivine in rock 12040 and other basaltic fragments in the light of analysis and synthesis. *Proc. Lunar Sci. Conf. 2nd*, pp. 575–582.
- Nicogossian A. E., Huntton C. L., and Pool S. L., eds. (1989) *Space Physiology and Medicine*, 2nd edition. Lea and Febiger, Philadelphia. 401 pp.
- Nord G. L. Jr. and James O. B. (1978) Consortium breccia 73255: Thermal and deformational history of bulk

- breccia and clasts, as determined by electron petrography. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 821–839.
- Nord G. L. Jr. and Wandless M.-V. (1983) Petrology and comparative thermal and mechanical histories of clasts in breccia 62236. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 88, A645–A657.
- Nord G. L. Jr., Christie J. M., Heuer A. H., and Lally J. S. (1975) North Ray Crater breccias: an electron petrographic study. *Proc. Lunar Sci. Conf. 6th*, pp. 779–797.
- Nordmeyer E. F. (1967) *Lunar Surface Mechanical Properties Derived from Track Left by Nine-Meter Boulder*. MSC Internal Note No. 67–TH-1, NASA Manned Spacecraft Center, Houston.
- Norman M. D. (1981) Petrology of suevitic lunar breccia 67016. *Proc. Lunar Planet. Sci. 12B*, pp. 235–252.
- Norman M. D. and Ryder G. (1980a) Geochemical evidence for the role of ilmenite and clinopyroxene in the early lunar differentiation (abstract). In *Lunar and Planetary Science XI*, pp. 821–823. Lunar and Planetary Institute, Houston.
- Norman M. D. and Ryder G. (1980b) Geochemical constraints on the igneous evolution of the lunar crust. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 531–559.
- Norris S. J., Swart P. K., Wright I. P., Grady M. M., and Pillinger C. T. (1983) A search for correlatable, isotopically light carbon and nitrogen in lunar soils and breccias. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B200–B210.
- Nunes P. D. and Tatsumoto M. (1973) Excess lead in “rusty rock” 66095 and implications for an early lunar differentiation. *Science*, 182, 916–920.
- Nunes P. D., Tatsumoto M., Knight R. J., Unruh D. M., and Doe B. R. (1973) U-Th-Pb systematics of some Apollo 16 lunar samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1797–1822.
- Nunes P. D., Knight R. J., Unruh D. M., and Tatsumoto M. (1974a) The primitive nature of the lunar crust and the problem of initial Pb isotopic compositions of a lunar rock: A Rb-Sr and U-Th-Pb study of Apollo 16 samples (abstract). In *Lunar Science V*, pp. 559–561. The Lunar Science Institute, Houston.
- Nunes P. D., Tatsumoto M., and Unruh D. M. (1974b) U-Th-Pb systematics of some Apollo 17 samples (abstract). In *Lunar Science V*, pp. 562–564. The Lunar Science Institute, Houston.
- Nunes P. D., Tatsumoto M., and Unruh D. (1974c) U-Th-Pb systematics of some Apollo 17 lunar samples and implications for a lunar basin excavation chronology. *Proc. Lunar Sci. Conf. 5th*, pp. 1487–1514.
- Nunes P. D., Tatsumoto M., and Unruh D. M. (1975) U-Th-Pb systematics of anorthositic gabbros 78155 and 77017—implications for early lunar evolution. *Proc. Lunar Sci. Conf. 6th*, pp. 1431–1444.
- Nyquist L. E. (1977) Lunar Rb-Sr chronology. *Phys. Chem. Earth*, 10, 103–142.
- Nyquist L. E. (1982) Radiometric ages and isotopic systematics of pristine plutonic lunar rocks (abstract). In *Workshop on Magmatic Processes of Early Planetary Crusts* (D. Walker and I. S. McCallum, eds.), pp. 114–120. LPI Tech Rpt. 82–01, Lunar and Planetary Institute, Houston.
- Nyquist L. E., Wiesmann H., Shih C.-Y., and Bansal B. M. (1977) REE and Rb-Sr analysis of 15405 quartz-monzodiorite (super-KREEP) (abstract). In *Lunar Science VIII*, pp. 738–740. The Lunar Science Institute, Houston.
- Nyquist L. E., Wiesmann H., Bansal B., Wooden J., and McKay G. (1978) Chemical and Sr-isotopic characteristics of the Luna 24 samples. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 631–656. Pergamon, New York.
- Nyquist L. E., Shih C.-Y., Wooden J. L., Bansal B. M., and Wiesmann H. (1979) The Sr and Nd isotopic record of Apollo 12 basalts: Implications for lunar geochemical evolution. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 77–114.
- Oberbeck V. R. (1975) The role of ballistic erosion and sedimentation in lunar stratigraphy. *Rev. Geophys. Space Phys.*, 13, 377–362.
- Oberbeck V. R. (1977) Application of high explosive cratering to planetary problems. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 45–66. Pergamon, New York.
- Oberbeck V. R. and Quaide W. L. (1968) Genetic implications of lunar regolith thickness variations. *Icarus*, 9, 446–465.
- Oberbeck V. R., Quaide W. L., and Greeley R. (1969) On the origin of lunar sinuous rilles. *Mod. Geol.*, 1, 75–80.
- Oberbeck V. R., Greeley R., Morgan R. B., and Lovas M. J. (1971) *Lunar Rilles—A Catalog and Method of Classification*. NASA TM X-62,088. 83 pp.
- Oberbeck V. R., Morrison R. H., Hörz F., Quaide W. L., and Gault D. E. (1974) Smooth plains and continuous deposits of craters and basins. *Proc. Lunar Sci. Conf. 5th*, pp. 111–136.
- Oberst J. and Nakamura Y. (1986) Distinct meteoroid families identified on the lunar seismograms. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E769–E773.
- O'Hara M. J. and Humphries D. J. (1975) Armalcolite crystallization, phenocryst assemblages, eruption conditions and origin of eleven high titanium basalts from Taurus Littrow (abstract). In *Lunar Science VI*, pp. 619–621. The Lunar Science Institute, Houston.
- O'Hara M. J., Biggar G. M., Hill P. G., Jeffries B., and Humphries D. J. (1974) Plagioclase saturation in lunar high-Ti basalt. *Earth Planet. Sci. Lett.*, 21, 253–268.
- O'Keefe J. D. and Ahrens T. J. (1975) Shock effects from a large impact on the moon. *Proc. Lunar Sci. Conf. 6th*, pp. 2831–2844.
- Olhoef G. R. (1979) Impulse radar studies of near surface geological structure (abstract). In *Lunar and Planetary Science X*, pp. 943–945. Lunar and Planetary Institute, Houston.
- Olhoef G. R. (1984) Applications and limitations of ground penetrating radar. In *Expanded Abstracts, 54th Ann. Int. Meeting and Expo. of the Soc. of Explor. Geophys.*, pp. 147–148. Atlanta, Georgia.

- Olhoeft G. R. and Strangway D. W. (1975) Dielectric properties of the first 100 meters of the Moon. *Earth Planet. Sci. Lett.*, 24, 394–404.
- Olhoeft G. R., Strangway D. W., and Frisillo A. L. (1973a) Lunar sample electrical properties. *Proc. Lunar Sci. Conf. 4th*, pp. 3133–3149.
- Olhoeft G. R., Strangway D. W., Pearce G. W., Frisillo A. L., and Gose W. A. (1973b) Electrical and magnetic properties of Apollo 17 soils. *Eos Trans. AGU*, 54, pp. 601.
- Olhoeft G. R., Frisillo A. L., Strangway D. W., and Sharpe H. (1974a) Temperature dependence of electrical conductivity and lunar temperatures. *The Moon*, 9, 79–87.
- Olhoeft G. R., Frisillo A. L., and Strangway D. W. (1974b) Electrical properties of lunar soil sample 15301,38. *J. Geophys. Res.*, 79, 1599–1604.
- Olhoeft G. R., Strangway D. W., and Pearce G. W. (1975) Effects of water on electrical properties of lunar fines. *Proc. Lunar Sci. Conf. 6th*, 3333–3342.
- Olhoeft G. R., Schaefer B., and Johnson G. R. (1979) Experimental measurements of surface and volume scattering processes at microwave wavelengths (abstract). In *Lunar and Planetary Science X*, pp. 946–948. Lunar and Planetary Institute, Houston.
- Onorato P. I. K., Uhlmann D. R., and Simonds C. H. (1976) Heat flow in impact melts: Apollo 17 Station 6 Boulder and some application to other breccias and xenolith laden melts. *Proc. Lunar Sci. Conf. 7th*, pp. 2449–2467.
- Onorato P. I. K., Uhlmann D. R., Taylor L. A., Coish R. A., and Gamble R. P. (1978) Olivine cooling speedometers. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 613–628.
- Orphal D. L. (1977) Calculations of explosive cratering—II: Cratering mechanics and phenomenology. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 907–918. Pergamon, New York.
- Orphal D. L., Borden W. F., Larson S. A., and Schultz P. H. (1980) Impact melt generation and transport. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 2309–2323.
- Ostertag R. (1983) Shock experiments on feldspar crystals. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B364–B376.
- Ostertag R., Stöffler D., Bischoff A., Palme H., Schulz L., Spettel B., Weber H., Weckwerth G., and Wänke H. (1986) Lunar meteorite Yamato-791197: Petrography, shock history and chemical composition. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 17–44. Natl. Inst. for Polar Res., Tokyo.
- Ostertag R., Stöffler D., Borhardt R., Palme H., Spettel B., and Wänke H. (1987) Precursor lithologies and metamorphic history of granulitic breccias from North Ray Crater, Station 11, Apollo 16. *Geochim. Cosmochim. Acta*, 51, 131–142.
- Ostro S. J. (1983) Planetary radar astronomy. *Rev. Geophys. Space Phys.*, 21, 186–196.
- Ozima M. and Podosek F. A. (1983) *Noble Gas Geochemistry*. Cambridge Univ., New York. 400 pp.
- Palme H. (1980) The meteoritic contamination of terrestrial and lunar impact melts and the problem of indigenous siderophiles in the lunar highlands. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 481–506.
- Palme H., Baddenhausen H., Blum K., Cendales M., Dreibus G., Hofmeister H., Kruse H., Palme C., Spettel B., Vilcsek E., Wänke H., and Kurat G. (1978) New data on lunar samples and achondrites and a comparison of the least fractionated samples from the Earth, the Moon and the Eucrite Parent Body. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 25–57.
- Palme H., Spettel B., Weckwerth G., and Wänke H. (1983) Antarctic meteorite ALHA 81005, a piece from the ancient lunar crust. *Geophys. Res. Lett.*, 10, 817–820.
- Palme H., Spettel B., Wänke H., Bischoff A., and Stöffler D. (1984) Early differentiation of the Moon: Evidence from trace elements in plagioclase. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C3–C15.
- Papanastassiou D. A. and Wasserburg G. J. (1971) Rb-Sr ages of igneous rocks from the Apollo 14 mission and the age of the Fra Mauro Formation. *Earth Planet. Sci. Lett.*, 12, 36–48.
- Papanastassiou D. A. and Wasserburg G. J. (1972) The Rb-Sr age of a crystalline rock from Apollo 16. *Earth Planet. Sci. Lett.*, 16, 289–298.
- Papanastassiou D. A. and Wasserburg G. J. (1976) Rb-Sr age of troctolite 76535. *Proc. Lunar Sci. Conf. 7th*, pp. 2035–2054.
- Papike J. J. and Bence A. E. (1978) Lunar mare versus terrestrial midocean ridge basalts: Planetary constraints on basaltic volcanism. *Geophys. Res. Lett.*, 5, 803–806.
- Papike J. J. and Cameron M. (1976) Crystal chemistry of silicate minerals of geophysical interest. *Rev. Geophys. Space Phys.*, 14, 37–80.
- Papike J. J. and Vaniman D. T. (1978) Luna 24 ferrobasalts and the mare basalt suite: Comparative chemistry, mineralogy, and petrology. In *Mare Crisium: The View from Luna 24* (J. J. Papike and R. B. Merrill, eds.), pp. 371–401. Pergamon, New York.
- Papike J. J., Bence A. E., Brown G. E., Prewitt C. T., and Wu C. H. (1971) Apollo 12 clinopyroxenes: Exsolution and epitaxy. *Earth Planet. Sci. Lett.*, 10, 307–315.
- Papike J. J., Bence A. E., and Lindsley D. H. (1974) Mare basalts from the Taurus-Littrow region of the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 471–504.
- Papike J. J., Hodges F. N., Bence A. E., Cameron M., and Rhodes J. M. (1976) Mare basalts: Crystal chemistry, mineralogy, and petrology. *Rev. Geophys. Space Phys.*, 14, 475–540.
- Papike J. J., Simon S. B., White C., and Laul J. C. (1981) The relationship of the lunar regolith <10 mm fraction and agglutinates. Part I: A model for agglutinate formation and some indirect supportive evidence. *Proc. Lunar Planet. Sci. 12B*, pp. 409–420.
- Papike J. J., Simon S. B., and Laul J. C. (1982) The lunar regolith: Chemistry, mineralogy, and petrology. *Rev. Geophys. Space Phys.*, 20, 761–826.
- Parker M. N. and Tyler G. L. (1973) Bistatic-radar estimation of surface-slope probability distributions with applications to the Moon. *Radio Sci.*, 8, 177–184.

- Pearce G. W. and Chou C. L. (1976) Relationships between siderophile elements and metallic iron contents of Apollo 16 and 17 lunar soils (abstract). In *Lunar Science VII*, pp. 673–675. The Lunar Science Institute, Houston.
- Pearce G. W., Gose W. A., and Lindsay J. (1975) Reduction of iron and regolith soil maturity (abstract). In *Lunar Science VI*, pp. 634–636. The Lunar Science Institute, Houston.
- Peckett A., Phillips R., and Brown G. M. (1972) New zirconium-rich minerals from Apollo 14 and 15 lunar rocks. *Nature*, 236, 215–217.
- Peeples W. J., Sill W. R., May T. W., Ward S. H., Phillips R. J., Jordan R. L., Abbott E. A., and Killpack T. J. (1978) Orbital radar evidence for lunar subsurface layering in Maria Serenitatis and Crisium. *J. Geophys. Res.*, 83, 3459–3468.
- Pepin R. O. (1980) Rare gases in the past and present solar wind. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 411–421. Pergamon, New York.
- Pepin R. O., Nyquist L. E., Phinney D., and Black D. C. (1970) Rare gases in Apollo 11 lunar material. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1435–1454.
- Pepin R. O., Basford J. R., Dragon J. C., Coscio M. R., and Murthy V. R. (1974) Rare gases and trace elements in Apollo 15 drill core fines: Depositional chronologies and K-Ar ages, and production rates of spallation-produced ^3He , ^{21}Ne , ^{38}Ar versus depth. *Proc. Lunar Sci. Conf. 5th*, pp. 2149–2184.
- Pepin R. O., Dragon J. C., Johnson N. L., Bates A., Coscio M. R., and Murthy V. R. (1975) Rare gases and Ca, Sr, and Ba in Apollo 17 drill-core fines. *Proc. Lunar Sci. Conf. 6th*, pp. 2027–2055.
- Pepin R. O., Eddy J. A., and Merrill R. B., eds. (1980) *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites*. Pergamon, New York. 581 pp.
- Perry C. H., Agrawal D. K., Anastassakis E., Lowndes R. P. and Tornberg N. E. (1972) Far infrared and Raman spectroscopic investigations of lunar materials from Apollo 11, 12, 14 and 15. *Proc. Lunar Sci. Conf. 3rd*, pp. 3077–3095.
- Peterson D. W. and Swanson D. A. (1974) Observed formation of lava tubes. *Speleology*, 2, 209.
- Petrov G. I. (1972) Investigation of the Moon with the Lunokhod 1 space vehicle. In *COSPAR Space Research XII*, pp. 1–12. Akademie-Verlag, Berlin.
- Petrowski C., Kerridge J. F., and Kaplan I. R. (1974) Light-element geochemistry of the Apollo 17 site. *Proc. Lunar Sci. Conf. 5th*, pp. 1939–1948.
- Pettengill G. H. (1978) Physical properties of the planets and satellites from radar observations. *Annu. Rev. Astron. Astrophys.*, 17, 265–292.
- Pettengill G. H. and Thompson T. W. (1968) A radar study of the lunar crater Tycho at 3.8 cm and 70 cm wavelengths. *Icarus*, 8, 457–471.
- Pettengill G. H., Zisk S. H., and Thompson T. W. (1974) The mapping of lunar radar scattering characteristics. *The Moon*, 10, 3–16.
- Pettijohn F. J., Potter P. E., and Siever R. (1973) *Sand and Sandstone*. Springer-Verlag, New York. 618 pp.
- Phillips R. J. and Dvorak J. (1981) The origin of lunar mascons: Analysis of the Bouguer gravity associated with Grimaldi. In *Multi-Ring Basins, Proc. Lunar Sci. Conf. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 91–104. Pergamon, New York.
- Phillips R. J. and Lambeck K. (1980) Gravity fields of the terrestrial planets: Long wavelength anomalies and tectonics. *Rev. Geophys. Space Phys.*, 18, 27–76.
- Phillips R. J., Conel J. E., Abbott E. A., Sjogren W. L., and Morton J. B. (1972) Mascons: Progress toward a unique solution for mass distribution. *J. Geophys. Res.*, 77, 7106–7114.
- Phillips R. J., Adams G. F., Brown W. E. Jr., Eggleton R. E., Jackson P., Jordan R., Linlor W. I., Peeples W. J., Porcello L. J., Ryu J., Schaber G., Sill W. R., Thompson T. W., Ward S. H., and Zelenka J. S. (1973a) Apollo Lunar Sounder Experiment. In *Apollo 17 Preliminary Science Report*, pp. 22–1 to 22–6. NASA SP-330.
- Phillips R. J., Adams G. F., Brown W. E. Jr., Eggleton R. E., Jackson, P., Jordan R., Peeples W. J., Porcello L. J., Ryu J., Schaber G., Sill W. R., Thompson T. W., Ward S. H., and Zelenka J. S. (1973b) The Apollo 17 lunar sounder. *Proc. Lunar Sci. Conf. 4th*, pp. 2821–2831.
- Philpotts J. A. and Schnetzler C. C. (1970) Apollo 11 samples: K, Rb, Sr, Ba, and rare-earth concentrations in some rocks and separated phases. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1471–1486.
- Philpotts J. A., Schnetzler C. C., Bottino M. L., Schuhmann S., and Thomas H. H. (1972) Luna 16: Some Li, K, Rb, Sr, Ba, rare-earth, Zr, and Hf concentrations. *Earth Planet. Sci. Lett.*, 13, 429–435.
- Philpotts J. A., Schuhmann S., Kouns C. W., Lum R. K. L., and Winzer S. (1974) Origin of Apollo 17 rocks and soils. *Proc. Lunar Sci. Conf. 5th*, pp. 1255–1267.
- Phinney D., Kahl S. B., and Reynolds J. H. (1975) ^{40}Ar - ^{39}Ar dating of Apollo 16 and Apollo 17 rocks. *Proc. Lunar Sci. Conf. 6th*, pp. 1593–1608.
- Phinney W. C. and Simonds C. H. (1977) Dynamical implications of the petrology and distribution of impact melt rocks. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 771–790. Pergamon, New York.
- Phinney W. C., Warner J. L., and Simonds C. H. (1977) Lunar highland rock types: Their implications for impact-induced fractionation. In *The Soviet-American Conference on Cosmochemistry of the Moon and Planets*, pp. 91–126. NASA SP-370.
- Pieters C. M. (1977) Characterization of lunar mare basalt types—II: Spectral classification of fresh mare craters. *Proc. Lunar Sci. Conf. 8th*, pp. 1037–1048.
- Pieters C. M. (1978) Mare basalt types on the front side of the Moon. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2825–2849.
- Pieters C. M. (1982) Copernicus crater central peak: Lunar mountain of unique composition. *Science*, 215, 59–61.

- Pieters C. M. (1983) Strength of mineral absorption features in the transmitted component of near-infrared reflected light: First results from RELAB. *J. Geophys. Res.*, 88, 9534–9544.
- Pieters C. M. (1986) Composition of lunar highland crust from near-infrared spectroscopy. *Rev. Geophys.*, 24, 557–578.
- Pieters C. M. (1989) Compositional diversity and stratigraphy of the lunar highland crust (abstract). In *Lunar and Planetary Science XX*, pp. 848–849. Lunar and Planetary Institute, Houston.
- Pieters C. M. and McCord T. B. (1976) Characterization of lunar mare basalt types: I. A remote sensing study using reflection spectroscopy of surface soils. *Proc. Lunar Sci. Conf. 7th*, pp. 2677–2690.
- Pieters C. M. and Mustard J. F. (1988) Exploration of crustal/mantle material for the Earth and Moon using reflectance spectroscopy. *Remote Sens. Environ.*, 24, 151–178.
- Pieters C., McCord T. B., Zisk S., and Adams J. B. (1973) Lunar black spots and nature of the Apollo 17 landing site. *J. Geophys. Res.*, 78, 5867–5875.
- Pieters C., Head J., McCord T. B., Adams J. B., and Zisk S. H. (1975) Geochemical and geological units of Mare Humorum: Definition using remote sensing and lunar sample information. *Proc. Lunar Sci. Conf. 6th*, pp. 2689–2710.
- Pieters C. M., Head J. W., Adams J. B., McCord T. B., Zisk S. H., and Whitford-Stark J. L. (1980) Late high-titanium basalts of the western maria: Geology of the Flamsteed region of Oceanus Procellarum. *J. Geophys. Res.*, 85, 3913–3938.
- Pieters C. M., Hawke B. R., Gaffey M. J., and McFadden L. A. (1983) Possible lunar source areas of meteorite ALHA81005: Geochemical remote sensing information. *Geophys. Res. Lett.*, 10, 813–816.
- Pieters C. M., Adams J. B., Mouginiis-Mark P., Zisk S. H., Smith M. O., Head J. W., and McCord T. B. (1985) The nature of crater rays: The Copernicus example. *J. Geophys. Res.*, 90, 12393–12413.
- Pike R. J. (1968) *Preliminary Models of Slope Distributions on the Moon*. U.S. Geological Survey, unpublished manuscript.
- Pike R. J. (1974a) Ejecta from large craters on the Moon: Comments on the geometric model of McGetchin et al. *Earth Planet. Sci. Lett.*, 23, 265–274.
- Pike R. J. (1974b) Depth/diameter relations of fresh lunar craters: Revision from spacecraft data. *Geophys. Res. Lett.*, 1, 291–294.
- Pike R. J. (1976) Crater dimensions from Apollo data and supplemental sources. *The Moon*, 15, 463–477.
- Pike R. J. (1977) Apparent depth/apparent diameter relation for lunar craters. *Proc. Lunar Sci. Conf. 8th*, pp. 3427–3436.
- Pike R. J. (1980) Formation of complex impact structures: Evidence from Mars and other planets. *Icarus*, 43, 1–19.
- Pike R. J. and Spudis P. (1987) Basin-ring spacing on the Moon, Mercury, and Mars. *Earth, Moon and Planets*, 39, 129–194.
- Pillinger C. T., Davis P. R., Eglinton G., Gowar A. P., Jull A. J. T., Maxwell J. R., Housley R. M., and Cirlin E. H. (1974) The association between carbide and finely divided metallic iron in lunar fines. *Proc. Lunar Sci. Conf. 5th*, pp. 1949–1961.
- Piwinskii A. J. and Duba A. G. (1975) Feldspar electrical conductivity and the lunar interior. *Proc. Lunar Sci. Conf. 6th*, pp. 2899–2907.
- Podosek F. A. and Huneke J. C. (1973) Argon in Apollo 15 green glass spherules (15426): ^{40}Ar - ^{39}Ar age and trapped argon. *Earth Planet. Sci. Lett.*, 19, 413–421.
- Pohl J., Stöffler D., Gall H., and Ernstson K. (1977) The Ries impact crater. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 343–404. Pergamon, New York.
- Pohn H. A. and Wildey R. L. (1970) *A Photoelectric-Photographic Study of the Normal Albedo of the Moon*. U.S. Geol. Surv. Prof. Pap. 599E.
- Pohn H. A., Radin H. W., and Wildey R. L. (1969) The Moon's photometric function near zero phase angle from Apollo 8 photography. *Astrophys. J.*, 157, L193–L195.
- Pollack J. B. and Whitehill L. (1972) A multiple-scattering model of the diffuse component of lunar radar echoes. *J. Geophys. Res.*, 77, 4289–4303.
- Pomerantz M. A. and Duggal S. P. (1974) The sun and cosmic rays. *Rev. Geophys. Space Phys.*, 12, 343–361.
- Porcello L. J., Jordan R. L., Zelenka J. S., Adams G. F., Phillips R. J., Brown W. E. Jr., Ward S. H., and Jackson P. L. (1974) The Apollo Lunar Sounder Radar System. *Proc. IEEE*, 62, 769–783.
- Powell B. N. and Weiblen P. W. (1972) Petrology and origin of lithic fragments in the Apollo 14 regolith. *Proc. Lunar Sci. Conf. 3rd*, pp. 837–852.
- Powell B. N., Aitken F. K., and Weiblen P. W. (1973) Classification, distribution, and origin of lithic fragments from the Hadley-Apennine region. *Proc. Lunar Sci. Conf. 4th*, pp. 445–460.
- Powers M. C. (1953) A new roundness scale for sedimentary particles. *J. Sed. Petrol.*, 23, 117–119.
- Prinz M. and Keil K. (1977) Mineralogy, petrology and chemistry of ANT-suite rocks from the lunar highlands. *Phys. Chem. Earth*, 10, 215–237.
- Prinz M., Dowty E., Keil K., and Bunch T. E. (1973) Spinel troctolite and anorthosite in Apollo 16 samples. *Science*, 179, 74–76.
- Quaide W. and Bunch T. (1970) Impact metamorphism of lunar surface materials. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 711–729.
- Quaide W. L. and Oberbeck V. R. (1975) Development of the mare regolith: Some model considerations. *The Moon*, 13, 27–55.
- Quaide W., Oberbeck V., Bunch T., and Polkowski G. (1971) Investigations of the natural history of the regolith at the Apollo 12 site. *Proc. Lunar Sci. Conf. 2nd*, pp. 701–718.
- Quick J. E., James O. B., and Albee A. L. (1981a) Petrology and petrogenesis of lunar breccia 12013. *Proc. Lunar Planet. Sci. 12B*, pp. 117–172.

- Quick J. E., James O. B., and Albee A. L. (1981b) A reexamination of the Rb-Sr isotopic systematics of lunar breccia 12013. *Proc. Lunar Planet. Sci. 12B*, pp. 173-184.
- Ramdohr P. (1972) Lunar pentlandite and sulfidization reactions in microbreccia 14315, 9. *Earth Planet. Sci. Lett.*, 15, 113-115.
- Ramdohr P. and El Goresy A. (1970) Opaque minerals of the lunar rocks and dust from Mare Tranquillitatis. *Science*, 167, 615-618.
- Rammensee W. and Wänke H. (1977) On the partition coefficient of tungsten between metal and silicate and its bearing on the origin of the Moon. *Proc. Lunar Sci. Conf. 8th*, pp. 399-409.
- Rao D. B., Chondary U. V., Erstfeld T. E., Williams R. J., and Chang Y. A. (1979) Extraction processes for the production of aluminum, titanium, iron, magnesium, and oxygen from nonterrestrial sources. In *Space Resources and Space Settlements* (J. Billingham et al., eds), pp. 257-274. NASA SP-428.
- Ravine M. A. and Grieve R. A. F. (1986) An analysis of morphologic variation in simple lunar craters. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E75-E83.
- Rea D. G., Hetherington N., and Mifflin R. (1964) The analysis of radar echoes from the Moon. *J. Geophys. Res.*, 69, 5217-5223.
- Rea D. G., Hetherington N., and Mifflin R. (1965) A note on "The analysis of radar echoes from the Moon." *J. Geophys. Res.*, 70, 1565.
- Reasoner D. L. (1975) Lunar nightside electron fluxes. *Proc. Lunar Sci. Conf. 6th*, pp. 3023-3032.
- Reed G. W. Jr. and Jovanovic S. (1970) Halogens, mercury, lithium, and osmium in Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1487-1492.
- Reed G. W. Jr. and Jovanovic S. (1971) The halogens and other trace elements in Apollo 12 samples and the implications of halides, platinum metals, and mercury on surfaces. *Proc. Lunar Sci. Conf. 2nd*, pp. 1261-1276.
- Reed G. W. Jr. and Jovanovic S. (1972) Trace element comparisons between mare and Apennine-Front non-mare samples (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 247-249. The Lunar Science Institute, Houston.
- Reed G. W. Jr. and Jovanovic S. (1973a) The halogens in Luna 16 and Luna 20 soils. *Geochim. Cosmochim. Acta*, 37, 1007-1009.
- Reed G. W. Jr. and Jovanovic S. (1973b) Fluorine in lunar samples: Implications concerning fluorapatite. *Geochim. Cosmochim. Acta*, 37, 1457-1471.
- Reed G. W. Jr. and Jovanovic S. (1979) Near-surface daytime thermal conductivity in the lunar regolith. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1637-1647.
- Reed G. W. Jr., Goleb J. A., and Jovanovic S. (1971a) Surface-related Hg in lunar samples. *Science*, 172, 258-261.
- Reed G. W. Jr., Jovanovic S., and Fuchs L. H. (1971b) Fluorine and other trace elements in lunar plagioclase concentrates. *Earth Planet. Sci. Lett.*, 11, 354-358.
- Reed G. W. Jr., Jovanovic S., and Fuchs L. (1972) Trace element relations between Apollo 14 and 15 and other lunar samples, and the implications of a Moon-wide Cl-KREEP coherence and Pt-metal noncoherence. *Proc. Lunar Sci. Conf. 3rd*, pp. 1989-2001.
- Reed G. W. Jr., Allen R. O. Jr., and Jovanovic S. (1977) Volatile metal deposits on lunar soils—relation to volcanism. *Proc. Lunar Sci. Conf. 8th*, pp. 3917-3930.
- Reed S. J. B. and Taylor S. R. (1974) Meteoritic metal in Apollo 16 samples. *Meteoritics*, 9, 23-34.
- Reedy R. C. (1977) Solar proton fluxes since 1956. *Proc. Lunar Sci. Conf. 8th*, pp. 825-839.
- Reedy R. C. (1978) Planetary gamma-ray spectroscopy. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2961-2984.
- Reedy R. C. (1980) Lunar radionuclide records of average solar-cosmic-ray fluxes over the last ten million years. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds), pp. 365-386. Pergamon, New York.
- Reedy R. C. (1987) Nuclide production by primary cosmic-ray protons. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E703-E709.
- Reedy R. C. and Arnold J. R. (1972) Interaction of solar and galactic cosmic-ray particles with the Moon. *J. Geophys. Res.*, 77, 537-555.
- Reedy R. C., Arnold J. R., and Lal D. (1983) Cosmic-ray record in solar system matter. *Annu. Rev. Nucl. Part Sci.*, 33, 505-537.
- Rees C. E. and Thode H. G. (1972) Sulfur concentrations and isotope ratios in lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1479-1485.
- Rees C. E. and Thode H. G. (1974) Sulfur concentrations and isotope ratios in Apollo 16 and 17 samples. *Proc. Lunar Sci. Conf. 5th*, pp. 1963-1973.
- Reid A. M., Meyer C., Harmon R. S., and Brett R. (1970) Metal grains in Apollo 12 igneous rocks. *Earth Planet. Sci. Lett.*, 9, 1-5.
- Reid A. M., Warner J. L., Ridley W. I., and Brown R. W. (1973) Luna 20 soil: Abundance and composition of phases in the 45-125 micron fraction. *Geochim. Cosmochim. Acta*, 37, 1011-1030.
- Reid A. M., Duncan A. R., and Richardson S. H. (1977) In search of LKFM. *Proc. Lunar Sci. Conf. 8th*, pp. 2321-2338.
- Reid J. B. (1971) Apollo 12 spinels as petrogenetic indicators. *Earth Planet. Sci. Lett.*, 10, 351-356.
- Reimold W. U. and Stöffler D. (1978) Experimental shock metamorphism of dunite. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2805-2824.
- Reimold W. U., Nyquist L. E., Bansal B. M., Wooden J. L., Shih C.-Y., Weismann H., and Mackinnon I. D. R. (1985) Isotope analysis of crystalline impact melt rocks from Apollo 16 Stations 11 and 13, North Ray Crater. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C431-C448.
- Rennilson J. J. and Criswell D. R. (1974) Surveyor observations of lunar horizon-glow. *The Moon*, 10, 121-142.

- Rhee J. W., Berg O. E., and Wolf H. (1977) Electrostatic dust transport and Apollo 17 LEAM experiment. In *COSPAR Space Research XVII*, pp. 627–629. Pergamon, New York.
- Rhodes J. M. (1977) Some compositional aspects of lunar regolith evolution. *Philos. Trans. R. Soc. London, A285*, 293–301.
- Rhodes J. M. and Blanchard D. P. (1980) Chemistry of Apollo 11 low-K mare basalts. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 49–66.
- Rhodes J. M. and Blanchard D. P. (1981) Apollo 11 breccias and soils: Aluminous mare basalts or multi-component mixtures? *Proc. Lunar Planet. Sci. 12B*, pp. 607–620.
- Rhodes J. M. and Hubbard N. J. (1973) Chemistry, classification, and petrogenesis of Apollo 15 mare basalts. *Proc. Lunar Sci. Conf. 4th*, pp. 1127–1148.
- Rhodes J. M., Rodgers K. V., Shih C., Bansal B. M., Nyquist L. E., Wiesmann H., and Hubbard N. J. (1974) The relationships between geology and soil chemistry at the Apollo 17 landing site. *Proc. Lunar Sci. Conf. 5th*, pp. 1097–1117.
- Rhodes J. M., Adams J. B., Blanchard D. P., Charette M. P., Rodgers K. V., Jacobs J. W., Brannon J. C., and Haskin L. A. (1975) Chemistry of agglutinate fractions in lunar soils. *Proc. Lunar Sci. Conf. 6th*, pp. 2291–2307.
- Rhodes J. M., Hubbard N. J., Wiesmann H., Rodgers K. V., Brannon J. C., and Bansal B. M. (1976) Chemistry, classification, and petrogenesis of Apollo 17 mare basalts. *Proc. Lunar Sci. Conf. 7th*, pp. 1467–1489.
- Rhodes J. M., Blanchard D. P., Dungan M. A., Brannon J. C., and Rogers K. V. (1977) Chemistry of Apollo 12 mare basalts: Magma types and fractionation processes. *Proc. Lunar Sci. Conf. 8th*, pp. 1305–1338.
- Richart F. E., Hall J. R., and Woods R. D. (1970) *Vibrations of Soils and Foundations*. Prentice-Hall, Englewood Cliffs, New Jersey.
- Richter D., Simmons G., and Siegfried R. (1976) Microcracks, micropores and their petrologic interpretation for 72415 and 15418. *Proc. Lunar Sci. Conf. 7th*, pp. 1901–1923.
- Ridley W. I., Brett R., Williams R. J., Takeda H., and Brown R. W. (1972) Petrology of Fra Mauro basalt 14310. *Proc. Lunar Sci. Conf. 3rd*, pp. 159–170.
- Ridley W. I., Hubbard N. J., Rhodes J. M., Weismann H., and Bansal B. (1973) The petrology of lunar breccia 15445 and petrogenetic implications. *J. Geol.*, 81, 621–631.
- Ringwood A. E. (1970) Petrogenesis of Apollo 11 basalts and implications for lunar origin. *J. Geophys. Res.*, 75, 6453–6479.
- Ringwood A. E. (1978) Origin of the Moon (abstract). In *Lunar and Planetary Science IX*, pp. 961–963. Lunar and Planetary Institute, Houston.
- Ringwood A. E., Seifert S., and Wänke H. (1987) A komatiite component in Apollo 16 highland breccias: Implications for the nickel-cobalt systematics and bulk composition of the Moon. *Earth Planet. Sci. Lett.*, 81, 105–117.
- Roberts W. A. (1968) Shock crater characteristics. In *Shock Metamorphism of Natural Materials* (B. M. French and N. M. Short, eds.), pp. 101–114. Mono, Baltimore.
- Robertson P. B. and Grieve R. A. F. (1977) Shock attenuation at terrestrial impact structures. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 687–702. Pergamon, New York.
- Robertson P. B., Dence M. R., and Vos M. A. (1986) Deformation in rock-forming minerals from Canadian craters. In *Shock Metamorphism of Natural Materials* (B. M. French and N. M. Short, eds.), pp. 433–452. Mono, Baltimore.
- Roddy D. J., Ullrich G. W., Sauer F. M., and Jones G. H. S. (1977) Cratering motions and structural deformation in the rim of the Prairie Flat multiring explosion crater. *Proc. Lunar Sci. Conf. 8th*, pp. 3389–3407.
- Roedder E. and Weiblen P. W. (1972a) Petrographic features and petrologic significance of melt inclusions in Apollo 14 and 15 rocks. *Proc. Lunar Sci. Conf. 3rd*, pp. 251–279.
- Roedder E. and Weiblen P. W. (1972b) Occurrence of chromian, hercynitic spinel (“pleonaste”) in Apollo 14 samples and its petrologic implications. *Earth Planet. Sci. Lett.*, 15, 376–402.
- Rose H. J. Jr., Cuttitta F., Dwornik E. J., Canon M. K., Christian R. P., Lindsay J. R., Ligon D. T. Jr., and Larson R. R. (1970) Semimicro X-ray fluorescence analysis of lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1493–1497.
- Rose H. J. Jr., Cuttitta F., Ansell C. S., Canon M. K., Christian R. P., Dwornik E. J., Greenland L., and Dignon D. T. Jr. (1972) Compositional data for twenty-one Fra Mauro lunar materials. *Proc. Lunar Sci. Conf. 3rd*, pp. 1215–1229.
- Rose H. J. Jr., Cuttitta F., Berman S., Carron M. K., Christian R. P., Dwornik E. J., Greenland L. P., and Ligon D. T. Jr. (1973a) Compositional data for twenty-two Apollo 16 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1149–1158.
- Rose H. J. Jr., Canon M. K., Christian R. P., Cuttitta F., Dwornik E. J., and Dignon D. T. Jr. (1973b) Elemental analysis of some Apollo 16 samples (abstract). In *Lunar Science IV*, pp. 631–633. The Lunar Science Institute, Houston.
- Rose H. J. Jr., Cuttitta F., Berman S., Brown F. W., Canon M. K., Christian R. P., Dwornik E. J., and Greenland L. P. (1974a) Chemical composition of rocks and soils at Taurus-Littrow. *Proc. Lunar Sci. Conf. 5th*, pp. 1119–1133.
- Rose H. J. Jr., Brown F. W., Canon M. K., Christian R. P., Cuttitta F., Dwornik E. J., and Ligon D. T. Jr. (1974b) Composition of some Apollo 17 samples (abstract). In *Lunar Science V*, pp. 645–646. The Lunar Science Institute, Houston.
- Rose H. J. Jr., Baedeker P. A., Berman S., Christian R. P., Dwornik E. J., Finkelman R. B., and Schnepfe M. M. (1975) Chemical composition of rocks and soils returned by the Apollo 15, 16 and 17 missions. *Proc. Lunar Sci. Conf. 6th*, pp. 1363–1373.
- Rosenberg S. D. (1985) A lunar-based propulsion system. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 169–176. Lunar and Planetary Institute, Houston.
- Ross M., Bence A. E., Dwornik E. J., Clark J. R., and Papike J. J. (1970) Mineralogy of lunar clinopyroxenes, augite and pigeonite. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 839–848.

- Ross M., Huebner J. S., and Dowty E. (1973) Delineation of the one atmosphere augite-pigeonite miscibility gap for pyroxenes from lunar basalt 12021. *Am. Mineral.*, 58, 619–635.
- Rossiter J. R. (1977) Interpretation of radio interferometry depth sounding, with emphasis on random scattering from glaciers and the lunar surface. Ph.D. thesis, Univ. of Toronto. 220 pp.
- Russ G. P. III and Emerson M. T. III (1980) ^{53}Mn and ^{26}Al evidence for solar cosmic ray constancy—an improved model for interpretation. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 387–399. Pergamon, New York.
- Rust D. M. (1982) Solar flares, proton showers, and the space shuttle. *Science*, 216, 939–946.
- Rutherford M. J., Dixon S., and Hess P. (1980) Ilmenite saturation at high pressure in KREEP basalts: Origin of KREEP and Hi-TiO₂ in mare basalts (abstract). In *Lunar and Planetary Science XI*, pp. 966–967. Lunar and Planetary Institute, Houston.
- Ryder G. (1976) Lunar sample 15405: Remnant of a KREEP basalt-granite differentiated pluton. *Earth Planet. Sci. Lett.*, 29, 255–268.
- Ryder G. (1979) The chemical components of highlands breccias. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 561–581.
- Ryder G. (1981) Distribution of rocks at the Apollo 16 landing site. In *Workshop on Apollo 16* (O. B. James and F. Hörz, eds.), pp. 112–119. LPI Tech. Rpt. 81–01, Lunar and Planetary Institute, Houston.
- Ryder G. (1982) Lunar anorthosite 60025, the petrogenesis of lunar anorthosites, and the composition of the Moon. *Geochim. Cosmochim. Acta*, 46, 1591–1601.
- Ryder G. (1984) Olivine in lunar dunite 72415, a rather shallow-origin cumulate (abstract). In *Lunar and Planetary Science XV*, pp. 709–710. Lunar and Planetary Institute, Houston.
- Ryder G. (1985) *Catalog of Apollo 15 Rocks*. JSC Publ. No. 20787, Curatorial Branch Publ. 72. NASA Johnson Space Center, Houston. 1296 pp.
- Ryder G. (1987) Petrographic evidence for nonlinear cooling rates and a volcanic origin for Apollo 15 KREEP basalts. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E331–E339.
- Ryder G. and Blair E. (1982) KREEP glass and the exotic provenance of polymict breccia 66055. *Proc. Lunar Planet. Sci. Conf. 13th, J. Geophys. Res.*, 87, A147–A158.
- Ryder G. and Bower J. F. (1976) Poikilitic KREEP impact melts in the Apollo 14 white rocks. *Proc. Lunar Sci. Conf. 7th*, pp. 1925–1948.
- Ryder G. and Bower J. F. (1977) Petrology of Apollo 15 black-and-white rocks 15445 and 15455—fragments of the Imbrium impact melt sheet? *Proc. Lunar Sci. Conf. 8th*, pp. 1895–1923.
- Ryder G. and Norman M. D. (1978) *Catalog of Pristine Non-Mare Materials Part 2. Anorthosites*. JSC Publ. No. 14603, NASA Johnson Space Center, Houston. 86 pp.
- Ryder G. and Norman M. D. (1979) *Catalog of Pristine Non-Mare Materials Part 1. Non-Anorthosites (Revised)*. JSC Publ. No. 14565, NASA Johnson Space Center, Houston. 147 pp.
- Ryder G. and Norman M. D. (1980) *Catalog of Apollo 16 Rocks*. JSC Publ. No. 16904, Curatorial Branch Publ. 52, NASA Johnson Space Center, Houston. 1144 pp.
- Ryder G. and Spudis P. D. (1980) Volcanic rocks in the lunar highlands. In *Proceedings of the Conference on the Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 353–375. Pergamon, New York.
- Ryder G. and Taylor G. J. (1976) Did mare-type volcanism commence early in lunar history? *Proc. Lunar Sci. Conf. 7th*, pp. 1741–1755.
- Ryder G. and Wood J. A. (1977) Serenitatis and Imbrium impact melts: Implications for large-scale layering in the lunar crust. *Proc. Lunar Sci. Conf. 8th*, pp. 655–668.
- Ryder G., Stoesser D. B., Marvin U. B., Bower J. F., and Wood J. A. (1975) Boulder 1, Station 2, Apollo 17: Petrology and petrogenesis. *The Moon*, 14, 327–357.
- Ryder G., Stoesser D. B., and Wood J. A. (1977) Apollo 17 KREEPy basalt: A rock type intermediate between mare and KREEP basalts. *Earth Planet. Sci. Lett.*, 35, 1–13.
- Ryder G., Norman M. D., and Score R. A. (1980) The distinction of pristine and meteorite-contaminated highlands rocks using metal compositions. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 471–479.
- Saari J. M. and Shorthill R. W. (1967) *Isothermal and Isophotoc Atlas of the Moon*. NASA CR-855, prepared by Boeing Scientific Research Laboratories under contract NASW-982. 186 pp.
- Salomonovich A. E. and Losovskii B. Ya. (1963) Radio brightness distribution on the lunar disk at 0.8 cm. *Soviet Astron. A. J.*, 6, 833–839.
- Salpas P. A., Taylor L. A., and Lindstrom M. M. (1987) Apollo 17 KREEPy basalts: Evidence for nonuniformity of KREEP. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E340–E348.
- Sato M. (1978) Oxygen fugacity of basaltic magmas and the role of gas forming elements. *Geophys. Res. Lett.*, 5, 447–449.
- Sato M. (1979) The driving mechanism of lunar pyroclastic eruptions inferred from the oxygen fugacity behavior of Apollo 17 orange glass. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 311–325.
- Sato M., Hickling N. L., and McLane J. E. (1973) Oxygen fugacity values of Apollo 12, 14, and 15 lunar samples and reduced state of lunar magmas. *Proc. Lunar Sci. Conf. 4th*, pp. 1061–1079.
- Schaal R. B. and Hörz F. (1977) Shock metamorphism of lunar and terrestrial basalts. *Proc. Lunar Sci. Conf. 8th*, pp. 1697–1729.
- Schaal R. and Hörz F. (1980) Experimental shock metamorphism of lunar soil. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1679–1695.
- Schaal R. B., Hörz F., Thompson T. D., and Bauer J. F. (1979) Shock metamorphism of granulated, lunar basalt. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2547–2571.

- Schaber G. G. (1973a) Lava flows in Mare Imbrium: Geologic evaluation from Apollo orbital photography. *Proc. Lunar Sci. Conf. 4th*, pp. 73–92.
- Schaber G. G. (1973b) Eratosthenian volcanism in Mare Imbrium: Source of youngest lava flows. In *Apollo 17 Preliminary Science Report*, pp. 30–17. NASA SP-330.
- Schaber G. G., Thompson T. W. and Zisk S. H. (1975) Lava flows in Mare Imbrium, an evaluation of anomalously low Earth-based radar reflectometry. *The Moon*, 13, 395–423.
- Schaber G. G., Boyce J. M., and Moore H. J. (1976) The scarcity of mappable flow lobes on the lunar maria: Unique morphology of the Imbrium flows. *Proc. Lunar Sci. Conf. 7th*, pp. 2783–2800.
- Schaber G. G., McCauley J. F., Breed C. S., and Olhoeft G. R. (1986) Shuttle imaging radar—physical controls on signal penetration and subsurface scattering in the Eastern Sahara. *IEEE Trans. Geosci. Remote Sens.*, GE-24, 603–623.
- Schaeffer O. A. and Husain L. (1973) Isotopic ages of Apollo 17 lunar material. *Eos Trans. AGU*, 54, 614.
- Schaeffer O. A., Husain L., and Schaeffer G. A. (1976) Ages of highland rocks: The chronology of lunar basin formation revisited. *Proc. Lunar Sci. Conf. 7th*, pp. 2067–2092.
- Schimerman L. A. (1973) *Lunar Cartographic Dossier*. Defense Mapping Agency, St. Louis and NASA, Washington, DC.
- Schloerb F. P., Muhleman D. O., and Berge G. L. (1976) Lunar heat flow and regolith structure inferred from interferometric observations at a wavelength of 49.3 cm. *Icarus*, 29, 329–341.
- Schmidt O. Y. (1959) *A Theory of the Origin of the Earth*. Lawrence and Wishart, London. 139 pp.
- Schmitt H. H. (1973) Apollo 17 report on the valley of Taurus-Littrow. *Science*, 182, 681–690.
- Schmitt H. H. and Cernan E. A. (1973) A geological investigation of the Taurus-Littrow Valley. In *Apollo 17 Preliminary Science Report*, pp. 5–1 to 5–21. NASA SP-330.
- Schnetzler C. C. and Philpotts J. A. (1970) Partition coefficients of rare-earth elements between igneous matrix material and rock-forming mineral phenocrysts—II. *Geochim. Cosmochim. Acta*, 34, 331.
- Schnetzler C. C. and Philpotts J. A. (1971) Alkali, alkaline earth, and rare earth element concentrations in some Apollo 12 soils, rocks, and separated phases. *Proc. Lunar Sci. Conf. 2nd*, pp. 1101–1122.
- Schock R. N., Duba A., and Stocker R. L. (1980) Defect production and electrical conductivity in olivine (abstract). In *Lunar and Planetary Science XI*, pp. 987–989. Lunar and Planetary Institute, Houston.
- Schonfeld E. and Bielefeld M. J. (1978) Correlation of dark mantle deposits with high Mg/Al ratios. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3037–3048.
- Schonfeld E. and Meyer C. Jr. (1972) The abundances of components of the lunar soils by a least-squares mixing model and the formation age of KREEP. *Proc. Lunar Sci. Conf. 3rd*, pp. 1397–1420.
- Schubert G., Lingenfelter R. E., and Peale S. J. (1970) The morphology, distribution, and origin of lunar sinuous rilles. *Rev. Geophys. Space Phys.*, 8, 199–224.
- Schubert G., Schwartz K., Sonett C. P., Colburn D. S., and Smith B. F. (1973) Lunar electromagnetic scattering II. Magnetic fields and transfer functions for parallel propagation. *Proc. Lunar Sci. Conf. 4th*, pp. 2909–2923.
- Schultz L., Weber H. W., Spettel B., Hintenberger H., and Wänke H. (1977) Noble gas and element distribution in agglutinate and bulk grain size fractions of soil 15601. *Proc. Lunar Sci. Conf. 8th*, pp. 2799–2815.
- Schultz P. H. (1976a) *Moon Morphology*. Univ. of Texas, Austin. 626 pp.
- Schultz P. H. (1976b) Floor-fractured lunar craters. *The Moon*, 15, 241–273.
- Schultz P. H. and Gault D. E. (1975a) Seismic effects from major basin formations on the Moon and Mercury. *The Moon*, 12, 159–177.
- Schultz P. H. and Gault D. E. (1975b) Seismically induced modification of lunar surface features. *Proc. Lunar Sci. Conf. 6th*, pp. 2845–2862.
- Schultz P. H. and Gault D. E. (1985) Clustered impacts: Experiments and implications. *J. Geophys. Res.*, 90, 3701–3732.
- Schultz P. H. and Mendell W. (1978) Orbital infrared observations of lunar craters and possible implications for impact ejecta emplacement. *Proc. Lunar Sci. Conf. 9th*, pp. 2857–2883.
- Schultz P. H. and Merrill R. B., eds. (1981) *Multi-Ring Basins*, *Proc. Lunar Planet. Sci. 12A*. Pergamon, New York. 295 pp.
- Schultz P. H. and Spudis P. D. (1979) Evidence for ancient mare volcanism. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 2899–2918.
- Schultz P. H. and Spudis P. D. (1983) Beginning and end of lunar mare volcanism. *Nature*, 302, 233–236.
- Schultz P. H., Greeley R., and Gault D. E. (1976) Degradation of small surface features. *Proc. Lunar Sci. Conf. 7th*, pp. 985–1003.
- Schurmann K. and Hafner S. S. (1972) On the amount of ferric iron in plagioclases from lunar igneous rocks. *Proc. Lunar Sci. Conf. 3rd*, pp. 615–621.
- Schwerer F. C., Nagata T., and Fisher R. M. (1971) Electrical conductivity of lunar surface rocks and chondritic meteorites. *The Moon*, 2, 408–422.
- Schwerer F. C., Huffman G. P., Fisher R. M., and Nagata T. (1972) Electrical conductivity and Mossbauer study of Apollo lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 3173–3185.
- Schwerer F. C., Huffman G. P., Fisher R. M., and Nagata T. (1973) Electrical conductivity of lunar surface rocks at elevated temperatures. *Proc. Lunar Sci. Conf. 4th*, pp. 3151–3166.
- Schwerer F. C., Huffman G. P., Fisher R. M., and Nagata T. (1974) Electrical conductivity of lunar surface rocks; laboratory measurements and implications for lunar

- interior temperatures. *Proc. Lunar Sci. Conf. 5th*, pp. 2673–2687.
- Sclar C. B. and Bauer J. F. (1973) Shock effects in experimentally shocked terrestrial ilmenite, lunar ilmenite of rock fragments in the 1–10 mm fines (10085,19), and lunar rock 60015. *Proc. Lunar Sci. Conf. 4th*, pp. 841–859.
- Sclar C. B. and Bauer J. F. (1975) Shock-induced subsolidus reduction-decomposition of orthopyroxene and shock-induced melting in norite 78235. *Proc. Lunar Sci. Conf. 6th*, pp. 799–820.
- Scoon J. H. (1971) Chemical analyses of lunar samples 12040 and 12064. *Proc. Lunar Sci. Conf. 2nd*, pp. 1259–1260.
- Scoon J. H. (1972) Chemical analyses of lunar samples 14003, 14311, and 14321. *Proc. Lunar Sci. Conf. 3rd*, pp. 1335–1336.
- Scoon J. H. (1974) Chemical analysis of lunar samples from the Apollo 16 and 17 collections (abstract). In *Lunar Science V*, pp. 690–692. The Lunar Science Institute, Houston.
- Scott D. H., McCauley J. F., and West M. N. (1977) Geologic map of the west side of the Moon. *U.S. Geol. Surv. Map I-1034*, scale 1:5,000,000.
- Scott D. R. (1973) What is it like to walk on the Moon? *Nat. Geo.*, 144, 326–329.
- Scott R. F. (1968) The density of lunar surface soil. *J. Geophys. Res.*, 73, 5469–5471.
- Scott R. F. (1987) Failure. *Geotechnique*, 37, 423–466.
- Scott R. F. and Ko H. Y. (1968) Transient rocket-engine gas flow in soil. *AIAA J.*, 6, 258–264.
- Scott R. F. and Roberson F. I. (1967) Soil mechanics surface sampler: Lunar tests, results, and analyses. In *Surveyor 3 Mission Report. Part 2: Scientific Data and Results*, pp. 69–110. JPL Tech. Rpt. 32–1177, Jet Propulsion Laboratory, Pasadena.
- Scott R. F. and Roberson F. I. (1968a) Surveyor III—Soil mechanics surface sampler: Lunar surface tests, results, and analysis. *J. Geophys. Res.*, 73, 4045–4080.
- Scott R. F. and Roberson F. I. (1968b) Soil mechanics surface sampler. In *Surveyor Project Final Report, Part 2: Science Results*, pp. 195–206. JPL Tech. Rpt. 32–1265, Jet Propulsion Laboratory, Pasadena.
- Scott R. F. and Roberson F. I. (1969) Soil mechanics surface sampler. In *Surveyor Program Results*, pp. 171–179. NASA SP-184.
- Scott R. F. and Zuckerman K. A. (1971) Examination of returned Surveyor III surface sampler. *Proc. Lunar Sci. Conf. 2nd*, pp. 2743–2751.
- Scott R. F., Carrier W. D. III, Costes N. C., and Mitchell J. K. (1970) Mechanical properties of the lunar regolith, Part C of Preliminary geological investigation of the Apollo 12 landing site. In *Apollo 12 Preliminary Science Report*, pp. 161–182. NASA SP-235.
- Scott R. F., Carrier W. D. III, Costes N. C., and Mitchell J. K. (1971) Apollo 12 soil mechanics investigation. *Geotechnique*, 21, 1–14.
- Scrutton C. T. (1978) Periodic growth features in fossil organisms and length of day and month. In *Tidal Friction and the Earth's Rotation* (P. Brosche and J. Sundermann, eds.), pp. 154–196. Springer-Verlag, Heidelberg.
- See T. H., Hörz F., and Morris R. V. (1986) Apollo 16 impact-melt splashes: Petrography and major-element composition. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E3–E20.
- Sen P. N., Scala C., and Cohen M. H. (1981) A self-similar model for sedimentary rocks with application to the dielectric constant of fused glass beads. *Geophysics*, 46, 781–795.
- Shapiro I. I., Zisk S. H., Rogers A. E. E., Slade M. A., and Thompson T. W. (1972) Lunar topography—global determination by radar. *Science*, 178, 939–948.
- Sharpton V. L. (1985) Analysis of topography and implications for the tectonic evolution of the Moon and Venus. Ph.D. thesis, Brown Univ., Providence, Rhode Island. 175 pp.
- Sharpton V. L. and Head J. W. III (1982) Stratigraphy and structural evolution of southern Mare Serenitatis: A reinterpretation based on Apollo Lunar Sounder Experiment data. *J. Geophys. Res.*, 87, 10983–10998.
- Sharpton V. L., Head J. W., and Shorthill R. W. (1984) Analysis and interpretation of the Apollo Lunar Sounder data: A status report (abstract). In *Lunar and Planetary Science XV*, pp. 762–763. Lunar and Planetary Institute, Houston.
- Shaw H. R. and Swanson D. A. (1970) Eruption and flow rates of flood basalts. *Proceedings of the Second Columbia River Basalt Symposium* (E. H. Gilmour and D. Stradling, eds.), pp. 271–299. Eastern Washington State College, Cheney.
- Shervais J. W. and Taylor L. A. (1983) Micrographic granite: More from Apollo 14 (abstract). In *Lunar and Planetary Science XIV*, pp. 696–697. Lunar and Planetary Institute, Houston.
- Shervais J. W. and Taylor L. A. (1986) Petrologic constraints on the origin of the Moon. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds), pp. 173–201. Lunar and Planetary Institute, Houston.
- Shervais J. W., Taylor L. A., and Laul J. C. (1983) Ancient crustal components in the Fra Mauro breccias. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B177–B192.
- Shervais J. W., Taylor L. A., and Laul J. C. (1984a) Very high potassium (VHK) basalt: A new type of aluminous mare basalt from Apollo 14 (abstract). In *Lunar and Planetary Science XV*, pp. 768–769. Lunar and Planetary Institute, Houston.
- Shervais J. W., Taylor L. A., Laul J. C., and Smith M. R. (1984b) Pristine highland clasts in consortium breccia 14305: Petrology and geochemistry. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C25–C40.
- Shervais J. W., Taylor L. A., and Lindstrom M. M. (1985a) Apollo 14 mare basalts: Petrology and geochemistry of clasts from consortium breccia 14321. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C375–C395.

- Shervais J. W., Taylor L. A., Laul J. C., Shih C.-Y., and Nyquist L. E. (1985b) Very high potassium (VHK) basalt: Complications in mare basalt petrogenesis. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 90, D3-D18.
- Shih C.-Y., Haskin L. A., Wiesmann H., Bansal B. M., and Brannon J. C. (1975) On the origin of high-Ti mare basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 1255-1285.
- Shih C.-Y., Nyquist L. E., Bogard D. D., Wooden J. L., Bansal B. M., and Wiesmann H. (1985) Chronology and petrogenesis of a 1.8 g lunar granite clast: 14321,1062. *Geochim. Cosmochim. Acta*, 49, 411-426.
- Shih C.-Y., Nyquist L. E., Bogard D. D., Bansal B. M., Wiesmann H., Johnson P., Shervais J. W., and Taylor L. A. (1986) Geochronology and petrogenesis of Apollo 14 very high potassium basalts. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D214-D228.
- Shirley D. N. (1983) A partially molten magma ocean model. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 88, A519-A527.
- Shoemaker E. M. (1962) Interpretation of lunar craters. In *Physics and Astronomy of the Moon* (Z. Kopal, ed.), pp. 283-359. Academic, New York.
- Shoemaker E. M. (1965) *Preliminary Analysis of the Fine Structure of Mare Cognitum*. JPL Tech. Rpt. 32-700, Jet Propulsion Laboratory, Pasadena. 35 pp.
- Shoemaker E. M. (1970) Origin of fragmental debris on the lunar surface and the history of bombardment of the Moon. *Instituto de Investigaciones Geologicas de la Diputacion Provincial XXV*, pp. 27-56. Universidad de Barcelona. (Published in 1971.)
- Shoemaker E. M. (1972) Cratering history and early evolution of the Moon (abstract). In *Lunar Science III*, pp. 696-698. The Lunar Science Institute, Houston.
- Shoemaker E. M. (1977) Why study impact craters? In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 1-10. Pergamon, New York.
- Shoemaker E. M. (1983) Asteroid and comet bombardment of the Earth. *Annu. Rev. Earth Planet. Sci.*, 11, 15-41.
- Shoemaker E. M. and Hackman R. J. (1962) Stratigraphic basis for a lunar time scale. In *The Moon* (Z. Kopal, ed.), pp. 289-300. Academic, New York.
- Shoemaker E. M., Hackman R. J., and Eggleton R. E. (1962) Interplanetary correlation of geologic time. *Adv. Astron. Sci.*, 8, 70-89.
- Shoemaker E. M., Morris E. C., Batson R. M., Holt H. E., Larson K. B., Montgomery D. R., Rennilson J. J., and Whitaker E. A. (1968) Television observations from Surveyor. In *Surveyor Project Final Report, Part II*, pp. 21-136. JPL Tech. Rpt. 32-1265, Jet Propulsion Laboratory, Pasadena.
- Shoemaker E. M., Bailey N. G., Batson R. M., Dahlem D. H., Foss T. H., Grolier M. J., Goddard E. M., Hait M. H., Holt H. E., Larson K. B., Rennilson J. J., Schaber G. G., Schleicher D. L., Schmitt H. H., Sutton R. L., Swann G. A., Waters A. C., and West M. N. (1970a) Geologic setting of the lunar samples returned by the Apollo 11 Mission. In *Apollo 11 Preliminary Science Report*, pp. 41-84. NASA SP-214.
- Shoemaker E. M., Batson R. M., Bean A. L., Conrad C. Jr., Dahlem D., Goddard E. N., Hait M. T., Larson K. B., Schaber G. G., Schleicher D. L., Sutton R. L., Swann G. A., and Waters A. C. (1970b) Preliminary geologic investigation of the Apollo 12 landing site. Part A. Geology of the Apollo 12 landing site. In *Apollo 12 Preliminary Science Report*, pp. 113-182. NASA SP-235.
- Short N. M. and Foreman M. L. (1972) Thickness of impact crater ejecta on the lunar surface. *Mod. Geol.*, 3, 69-91.
- Sievers R. E., Eisentraut K. J., Griest D. J., Richardson M. F., Wolf W. R., Ross W. D., Frew N. M., and Isenhour T. L. (1971) Variations in beryllium and chromium contents in lunar fines compared with crystalline rocks. *Proc. Lunar Sci. Conf. 2nd*, pp. 1451-1459.
- Silberberg R., Tsao C. H., Adams J. H. Jr., and Letaw J. R. (1985) Radiation transport of cosmic ray nuclei in lunar material and radiation doses. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 663-669. Lunar and Planetary Institute, Houston.
- Sill W. R., Hansen W., Ward S. H., Katsube T. J., and Collett L. S. (1973) The dielectric properties of Apollo 14 and 16 rock and soil samples. Talk presented at the Conference on Geophysical and Geochemical Exploration of the Moon and Planets, January 10-12, The Lunar Science Institute, Houston.
- Silver L. T. (1970) Uranium-thorium-lead isotopes in some Tranquillity Base samples and their implication for lunar history. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1533-1574.
- Silver L. T. (1972) Uranium-thorium-lead isotopes and the nature of the mare surface debris at Hadley-Apennine (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 388-390. The Lunar Science Institute, Houston.
- Silver L. T. (1974a) Implications of volatile leads in orange, grey and green lunar soils for an Earth-like Moon (abstract). *Eos Trans. AGU*, 55, 681.
- Silver L. T. (1974b) Patterns of U-Th-Pb distributions and isotope relations in Apollo 17 soils (abstract). In *Lunar Science V*, pp. 706-708. The Lunar Science Institute, Houston.
- Silver L. T. and Schultz P. H., eds. (1982) *Geological Implications of Impacts of Large Asteroids and Comets on Earth*. Geol. Soc. Am. Spec. Pap. 190. 528 pp.
- Simkin T., Noonan A., Switzer G. S., Mason B., Nelen J. A., Melson W. G., and Thompson G. (1973) Composition of Apollo 16 fines 60051, 60052, 64811, 64812, 68821, and 68822. *Proc. Lunar Sci. Conf. 4th*, pp. 279-289.
- Simmons G., Strangway D. W., Bannister L., Baker R., Cubley D., La Torraca G., and Watts R. (1972) The surface electrical properties experiment. In *Lunar Geophysics* (Z. Kopal and D. W. Strangway, eds.), pp. 258-271. Reidel, Dordrecht.
- Simmons G., Strangway D., Annan P., Baker R., Bannister L., Brown R., Cooper W., Cubley D., deBettencourt J., England A. W., Groener J., Kong J., La Torraca G., Meyer J., Nanda V., Redman D., Rossiter J., Tsang L., Urner J., and

- Watts R. (1973) Surface electrical properties experiment. In *Apollo 17 Preliminary Science Report*, pp. 15-1 to 15-14. NASA SP-380.
- Simnett G. M. (1974) Relativistic electron events in interplanetary space. *Space Sci. Rev.*, 16, 257-323.
- Simnett G. M. (1976) Solar cosmic radiation during August 1972. *Space Sci. Rev.*, 19, 579-610.
- Simon M. C. (1985) A parametric analysis of lunar oxygen production. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 531-541. Lunar and Planetary Institute, Houston.
- Simon S. B. and Papike J. J. (1985) Petrology of the Apollo 12 highland component. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 90, D47-D60.
- Simon S. B., Papike J. J., and Laul J. C. (1981) The lunar regolith: Comparative studies of the Apollo and Luna sites. Petrology of soils from Apollo 17, Luna 16, 20, and 24. *Proc. Lunar Planet. Sci. 12B*, pp. 371-388.
- Simon S. B., Papike J. J., and Laul J. C. (1982) The Apollo 14 regolith: Petrology of cores 14210/14211 and 14220 and soils 14141, 14148, and 14149. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A232-A246.
- Simon S. B., Papike J. J., and Shearer C. K. (1984) Petrology of Apollo 11 regolith breccias. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C 109-C 132.
- Simon S. B., Papike J. J., Gosselin D. C., and Laul J. C. (1985) Petrology and chemistry of Apollo 12 regolith breccias. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 90, D75-D86.
- Simon S. B., Papike J. J., Gosselin D. C., and Laul J. C. (1986a) Petrology, chemistry and origin of Apollo 15 regolith breccias. *Geochim. Cosmochim. Acta*, 50, 2675-2691.
- Simon S. B., Papike J. J., Hörz F., and See T. H. (1986b) An experimental investigation of agglutinate melting mechanisms: Shocked mixtures of Apollo 11 and 16 soils. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E64-E74.
- Simon S. B., Papike J. J., Laul J. C., Hughes S. S., and Schmitt R. A. (1988) Apollo 16 regolith breccias and soils: Recorders of exotic component addition to the Descartes region of the moon. *Earth Planet. Sci. Lett.*, 89, 147-162.
- Simonds C. H. (1975) Thermal regimes in impact melts and the petrology of the Apollo 17 Station 6 boulder. *Proc. Lunar Sci. Conf. 6th*, pp. 641-672.
- Simonds C. H. (1981) Physics of the magma ocean: A critical review (abstract). In *Workshop on Apollo 16* (O. B. James and F. Hörz, eds.), pp. 123-128. LPI Tech. Rpt. 81-01, Lunar and Planetary Institute, Houston.
- Simonds C. H., Warner J. L., and Phinney W. C. (1973) Petrology of Apollo 16 poikilitic rocks. *Proc. Lunar Sci. Conf. 4th*, pp. 613-632.
- Simonds C. H., Warner J. L., and Phinney W. C. (1975) The petrology of the Apennine Front revisited (abstract). In *Lunar Science VI*, pp. 744-746. The Lunar Science Institute, Houston.
- Simonds C. H., Warner J. L., Phinney W. C., and McGee P. E. (1976) Thermal model for impact breccia lithification: Manicouagan and the Moon. *Proc. Lunar Sci. Conf. 7th*, pp. 2509-2528.
- Simonds C. H., Phinney W. C., Warner J. L., McGee P. E., Geeslin J., Brown R. W., and Rhodes J. M. (1977) Apollo 14 revisited, or breccias aren't so bad after all. *Proc. Lunar Sci. Conf. 8th*, pp. 1869-1893.
- Simoneit B. R., Christiansen P. C., and Burlingame A. L. (1973) Volatile element chemistry of selected lunar, meteoritic, and terrestrial samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1635-1650.
- Simpson J. A. (1983) Elemental and isotopic composition of the galactic cosmic rays. *Annu. Rev. Nucl. Part. Sci.*, 33, 323-381.
- Simpson P. R. and Bowie S. H. V. (1971) Opaque phases in Apollo 12 samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 207-218.
- Simpson R. A. and Tyler G. A. (1982) Radar scattering laws for the lunar surface. *IEEE Trans. Antennas and Propag.*, 30, 438-449.
- Sippel R. F. (1971) Luminescence petrography of the Apollo 12 rocks and comparative features in terrestrial rocks and meteorites. *Proc. Lunar Sci. Conf. 2nd*, pp. 247-263.
- Skinner B. J. (1970) High crystallization temperatures indicated for igneous rocks from Tranquillity Base. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 891-895.
- Smith E. I. (1973) Identification, distribution, and significance of lunar volcanic domes. *The Moon*, 6, 3-31.
- Smith E. I. and Sanchez A. G. (1973) Fresh lunar craters: Morphology as a function of diameter, a possible criterion for crater origin. *Mod. Geol.*, 4, 51-59.
- Smith J. V. (1974) Lunar mineralogy: A heavenly detective story, Presidential Address, Part 1. *Am. Mineral*, 59, 231-243.
- Smith J. V. and Steele I. M. (1974) Intergrowths in lunar and terrestrial anorthosites with implications for lunar differentiation. *Am. Mineral*, 59, 673-680.
- Smith J. V. and Steele I. M. (1976) Lunar mineralogy: A heavenly detective story. Part II. *Am. Mineral*, 61, 1059-1116.
- Smith J. V., Anderson A. T., Newton R. C., Olsen E. J., Wyllie P. J., Crewe A. V., Isaacson M. S., and Johnson D. (1970) Petrologic history of the Moon inferred from petrography, mineralogy, and petrogenesis of Apollo 11 rocks. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 897-925.
- Smith J. W. (1974) Carbon, nitrogen, and sulfur in lunar fines 15012 and 15013: Abundances, distributions and isotopic compositions. *Geochim. Cosmochim. Acta*, 38, 853-872.
- Smith J. W., Kaplan I. R., and Petrowski C. (1973) Carbon, nitrogen, sulfur, helium, hydrogen, and metallic iron in Apollo 15 drill stem fines. *Proc. Lunar Sci. Conf. 4th*, pp. 1651-1656.
- Smith P. M. (1985) Lunar stations: Prospects for international cooperation. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 717-723. Lunar and Planetary Institute, Houston.

- Smith W. B., Ingalls R. P., Shapiro I. I., and Ash M. E. (1970) Surface height variations on Venus and Mercury. *Radio Sci.*, 5, 411–423.
- Smrekar S. and Pieters C. M. (1985) Near-infrared spectroscopy of probable impact melt from three large lunar highland craters. *Icarus*, 63, 442–452.
- Smyth J. R. (1974) The crystal chemistry of armalcolites from Apollo 17. *Earth Planet. Sci. Lett.*, 24, 262–270.
- Smyth J. R. (1975) Intracrystalline cation order in a lunar crustal troctolite. *Proc. Lunar Sci. Conf. 6th*, pp. 821–832.
- Soderblom L. A. (1970) A model for small-impact erosion applied to the lunar surface. *J. Geol. Res.*, 75, 2655–2661.
- Soderblom L. A. and Lebofsky L. A. (1972) Technique for rapid determination of relative ages of lunar areas from orbital photography. *J. Geophys. Res.*, 77, 279–296.
- Solar System Exploration Committee (1983) *Planetary Exploration Through Year 2000, A Core Program*. U.S. Government Printing Office, Washington, DC. 167 pp.
- Solar System Exploration Committee (1986) *Planetary Exploration Through Year 2000, An Augmented Program*. U.S. Government Printing Office, Washington, DC. 239 pp.
- Solomon S. C. (1986) On the early thermal state of the Moon. In *Origin of the Moon* (W. K. Hartmann, R. J. Phillips, and G. J. Taylor, eds.), pp. 435–452. Lunar and Planetary Institute, Houston.
- Solomon S. C. and Chaiken J. (1976) Thermal expansion and thermal stress in the Moon and terrestrial planets: Clues to early thermal history. *Proc. Lunar Sci. Conf. 7th*, pp. 3229–3243.
- Solomon S. C. and Head J. W. (1979) Vertical movement in the mare basins: Relation to the mare emplacement, basin tectonics, and lunar thermal history. *J. Geophys. Res.*, 84, 1667–1682.
- Solomon S. C. and Head J. W. (1980) Lunar mascon basins: Lava flooding, tectonics, and evolution of the lithosphere. *Rev. Geophys. Space Phys.*, 18, 107–141.
- Solomon S. C., Corner R. P., and Head J. W. (1982) The evolution of impact basins: Viscous relaxation of topographic relief. *J. Geophys. Res.*, 87, 3975–3992.
- Sonett C. P. (1982) Electromagnetic induction in the Moon. *Rev. Geophys. Space Phys.*, 20, 411–456.
- Sonett C. P. and Duba A. (1975) Lunar temperature and global heat flux from laboratory electrical conductivity and lunar magnetometer data. *Nature*, 258, 118–121.
- Sonett C. P., Giampapa M., and Matthews M. S., eds. (1990) *The Sun in Time*. Univ. of Arizona, Tucson, in press.
- Spangenburg R. and Moser D. (1987) A question of gravity. *Space World, February*, 8–11.
- Spudis P. D. (1984) Apollo 16 site geology and impact melts: Implications for the geologic history of the lunar highlands. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C95–C107.
- Spudis P. D. and Davis P. A. (1986) A chemical and petrologic model of the lunar crust and implications for lunar crustal origin. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 91, E84–E90.
- Spudis P. D. and Ryder G. (1981) Apollo 17 impact melts and their relation to the Serenitatis basin. In *Multi-Ring Basins, Proc. Lunar Planet. Sci. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 133–148. Pergamon, New York.
- Spudis P. D. and Ryder G. (1985) Geology and petrology of the Apollo 15 landing site: Past present, and future understanding. *Eos Trans. AGU*, 66, 721–726.
- Spudis P. D. and Ryder G., eds. (1986) *Workshop on the Geology and Petrology of the Apollo 15 Landing Site*. LPI Tech. Rpt. 86–03, Lunar and Planetary Institute, Houston. 126 pp.
- Spudis P. D., Hawke B. R., and Lucey P. (1984) Compositions of Orientale Basin deposits and implications for the lunar basin-forming process. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C197–C210.
- Stahle V. (1972) Impact glasses from the suevite of the Nordlinger Ries. *Earth Planet. Sci. Lett.*, 17, 275–293.
- Stanin F. T. and Taylor L. A. (1979a) Armalcolite/ilmenite: Mineral chemistry, paragenesis, and origin of textures. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 383–405.
- Stanin F. T. and Taylor L. A. (1979b) Ilmenite/armalcolite: Effects of rock composition, oxygen fugacity and cooling rate (abstract). In *Lunar and Planetary Science X*, pp. 1160–1162. Lunar and Planetary Institute, Houston.
- Stanin F. T. and Taylor L. A. (1980) Armalcolite: An oxygen fugacity indicator. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 117–124.
- Staudacher T., Jessberger E. K., Dominik B., Kirsten T., and Schaeffer O. (1982) $^{40}\text{Ar}/^{39}\text{Ar}$ ages of rocks and glasses from the Nordlinger Ries Crater and the temperature history of impact breccias. *J. Geophys. Res.*, 87, 1–11.
- Steele I. M. (1974) Ilmenite and armalcolite in Apollo 17 breccias. *Am. Mineral.*, 59, 681–689.
- Steele I. M. and Smith J. V. (1972) Ultrabasic lunar samples. *Nature Phys. Sci.*, 240, 5–6.
- Steele I. M. and Smith J. V. (1975) Minor elements in lunar olivine as a petrologic indicator. *Proc. Lunar Sci. Conf. 6th*, 451–467.
- Steele I. M. and Smith J. V. (1976) Mineralogy and petrology of complex breccia 14063,14. *Proc. Lunar Sci. Conf. 7th*, pp. 1949–1964.
- Steele I. M., Smith J. V., and Grossman L. (1972) Mineralogy and petrology of Apollo 15 rake samples: I. Basalts. In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 158–160. The Lunar Science Institute, Houston.
- Stephenson A., Collinson D. W., and Runcorn S. K. (1978) Rock magnetic and paleomagnetic studies on Luna 24 samples. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. Papike, eds.), pp. 701–709. Pergamon, New York.
- Stettler A., Eberhardt P., Geiss J., Grögler N., and Maurer P. (1973) $\text{Ar}^{39}\text{-Ar}^{40}$ ages and $\text{Ar}^{37}\text{-Ar}^{38}$ exposure ages of lunar rocks. *Proc. Lunar Sci. Conf. 4th*, pp. 1865–1888.
- Stewart D. B. (1975) Apollonian metamorphic rocks—the products of prolonged subsolidus equilibration (abstract). In *Lunar Science VI*, pp. 774–776. The Lunar Science Institute, Houston.
- Stoener R. W., Davis R. Jr., Norton E., and Bauer M. (1974) Radioactive rare gases, tritium, hydrogen, and helium in

- the sample return container, and in the Apollo 16 and 17 drill stems. *Proc. Lunar Sci. Conf. 5th*, pp. 2211–2229.
- Stoeser D. B., Wolfe R. W., Wood J. A., and Bower J. F. (1974) Petrology. In *Interdisciplinary Studies of Samples from Boulder 1, Station 2, Apollo 17* (J. A. Wood, ed.), pp. 35–109. Smithsonian Astrophysical Observatory, Cambridge, Massachusetts.
- Stöffler D. (1971) Progressive metamorphism and classification of shocked and brecciated crystalline rocks at impact craters. *J. Geophys. Res.*, 76, 5541–5551.
- Stöffler D. (1972) Deformation and transformation of rock-forming minerals by natural and experimental shock processes. I. Behavior of minerals under shock compression. *Fortschr. Mineral.*, 49, 5477–5488.
- Stöffler D. (1974) Deformation and transformation of rock forming minerals by natural and experimental shock processes. II. Physical properties of shocked minerals. *Fortschr. Mineral.*, 51, 256–289.
- Stöffler D. (1981) Cratering mechanics: Data from terrestrial and experimental craters and implications for the Apollo 16 site (abstract). In *Workshop on Apollo 16* (O. B. James, ed.), pp. 132–141. LPI Tech. Rpt. 81–01, Lunar and Planetary Institute, Houston.
- Stöffler D. (1982) Physical properties of rocks. Density of minerals and rocks under shock compression. In *Numerical Data and Functional Relationships in Science and Technology, Group V. Geophysics and Space Research* (G. Angenheister, ed.), pp. 120–183. Springer-Verlag, Berlin.
- Stöffler D. (1984) Glasses formed by hypervelocity impact. *J. Noncryst. Solids*, 67, 465–505.
- Stöffler D., Dence M. R., Graup G., and Abadian M. (1974) Interpretation of ejecta formations at the Apollo 14 and 16 sites by a comparative analysis of experimental, terrestrial, and lunar craters. *Proc. Lunar Sci. Conf. 5th*, pp. 137–150.
- Stöffler D., Gault D. E., Wedekind J., and Polkowski G. (1975) Experimental hypervelocity impact into sand: Distribution and shock metamorphism of ejecta. *J. Geophys. Res.*, 80, 4062–4077.
- Stöffler D., Knöll H.-D., and Maerz U. (1979) Terrestrial and lunar impact breccias and the classification of lunar highland rocks. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 639–675.
- Stöffler D., Knöll H.-D., Marvin U. B., Simonds C. H., and Warren P. H. (1980) Recommended classification and nomenclature of lunar highland rocks—a committee report. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 51–70. Pergamon, New York.
- Stöffler D., Ostertag R., Reimold U., Borchardt R., Malley J., and Rehfeldt A. (1981) Distribution and provenance of lunar highland rock types at North Ray Crater, Apollo 16. *Proc. Lunar Planet. Sci. 12B*, pp. 185–207.
- Stöffler D., Bischoff A., Borchardt R., Burghel A., Deutsch A., Jessberger E. K., Ostertag R., Palme H., Spettel B., Reimold W. U., Wacker K., and Wänke H. (1985) Composition and evolution of the lunar crust in the Descartes Highlands, Apollo 16. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C449–0506.
- Stolper E. M. (1974) Apollo 15 green glass. A.B. thesis, Harvard University. 178 pp.
- Stolper E. M. (1977) Experimental petrology of eucritic meteorites. *Geochim. Cosmochim. Acta*, 41, 587–611.
- Stone C. D., Taylor L. A., McKay D. S., and Morris R. V. (1982) Ferromagnetic resonance intensity: A rapid method for determining lunar glass bead origin. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A182–A196.
- Strangway D. W. (1969) Moon, electrical properties of the uppermost layers. *Science*, 165, 1012–1013.
- Strangway D. W. and Olhoeft G. R. (1977) Electrical properties of planetary surfaces. *Philos. Trans. R. Soc. London*, A285, 441–450.
- Strangway D. W., Chapman W. B., Olhoeft G. R., and Carnes J. (1972) Electrical properties of lunar soil—dependence upon frequency, temperature and moisture. *Earth Planet. Sci. Lett.*, 16, 275–281.
- Strangway D. W., Annan A. P., Redman J. D., Rossiter J. R., Rylaarsdam J. A., and Watts R. D. (1974) *Surface Electrical Properties Experiment, Parts 1, 2, and 3*. NASA Reports CR-141471, 141472, and 141473. 1355 pp. (total).
- Strangway D. W., Pearce G. W., and Olhoeft G. R. (1975) Magnetic and dielectric properties of lunar samples. In *Proceedings of the Soviet-American Conference on Cosmochemistry of the Moon and Planets*, pp. 712–728. Nauka, Moscow. Reprinted as NASA SP-370 (1977).
- Strasheim A., Hackson P. F. S., Coetzee J. H. J., Strelow F. W. E., Wybenga F. T., Gricius A. J., Kokot M. L., and Scott R. H. (1972) Analysis of lunar samples 14163, 14259, and 14321 with isotopic data for ${}^7\text{Li}/{}^6\text{Li}$. *Proc. Lunar Sci. Conf. 3rd*, pp. 1337–1342.
- Strom R. G. (1964) Analysis of lunar lineaments. I. Tectonic maps of the moon. *Commun. Lunar Planet. Lab.*, 2, 205–216.
- Strom R. G. (1977) Origin and relative age of lunar and mercurian intercrater plains. *Phys. Earth Planet. Inter.*, 15, 156–172.
- Stuart-Alexander D. E. (1978) Geologic map of the central farside of the Moon. *U.S. Geol. Survey Map I-1047*.
- Sung C. M., Abu-Eid R. M., and Burns R. G. (1974) $\text{Ti}^{3+}/\text{Ti}^{4+}$ ratios in lunar pyroxenes: Implications to depth of origin of mare basalt magma. *Proc. Lunar Sci. Conf. 5th*, pp. 717–726.
- Surkov Yu. A. and Kolesov G. M. (1979) Contents of rock-forming minor and trace elements as gauges of Luna 20 regolith characteristics. In *Regolith from the Highland Region of the Moon* (V. L. Barsukov and Yu. A. Surkov, eds.), pp. 345–354. Nauka, Moscow.
- Svitek T. and Murray B. C. (1988) Lunar polar ice—A reappraisal (abstract). In *Lunar and Planetary Science XIX*, p. 1160. Lunar and Planetary Institute, Houston.
- Swann G. A. (1986) Some observations on the geology of the Apollo 15 landing site (abstract). In *Workshop on the Geology and Petrology of the Apollo 15 Landing Site* (G. Ryder and P. D. Spudis, eds.), pp. 108–112. LPI Tech. Rpt. 86–03, Lunar and Planetary Institute, Houston.

- Swann G. A., Bailey N. G., Batson R. M., Freeman V. L., Hait M. H., Head J. W., Holt H. E., Howard K. A., Irwin J. B., Larson K. B., Muehlberger W. R., Reed V. S., Rennilson J. J., Schaber G. G., Scott D. R., Silver L. T., Sutton R. L., Ulrich G. E., Wilshire H. G., and Wolfe E. W. (1972) Preliminary geologic investigations of the Apollo 15 landing site. In *Apollo 15 Preliminary Science Report*, pp. 5-1 to 5-112. NASA SP-289.
- Swann G. A., Bailey N. G., Batson R. M., Eggleton R. E., Hait M. H., Holt H. E., Larson K. B., Reed V. S., Schaber G. G., Sutton R. L., Trask N. A., Ulrich G. E., and Wilshire H. G. (1977) *Geology of the Apollo 14 Landing Site in the Fra Mauro Highlands*. U.S. Geol. Surv. Prof. Pap. 800. 103 pp.
- Takeda H., Miyamoto M., Ishii T., and Lofgren G. E. (1975) Relative cooling rates of mare basalts at the Apollo 12 and 15 sites as estimated from pyroxene exsolution data. *Proc. Lunar Sci. Conf. 6th*, pp. 987-996.
- Takeda H., Mori H., Miyamoto M., and Ishii T. (1983) Mesostasis-rich lunar and eucritic basalts with reference to REE-rich minerals (abstract). In *Lunar and Planetary Science XIV*, pp. 842-843. Lunar and Planetary Institute, Houston.
- Tarasov L. S., Nazarov M. A., Shevaleevsky I. D., Kudryashova A. F., Gaverdovskaya A. S., and Korina M. I. (1977) Mineralogy and petrography of lunar rocks from Mare Crisium (preliminary data). *Proc. Lunar Sci. Conf. 8th*, pp. 3333-3356.
- Tatsumoto M. (1970) Age of the Moon: An isotopic study of U-Th-Pb systematics of Apollo 11 lunar samples—II. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1595-1612.
- Tatsumoto M. (1973) U-Th-Pb measurements of Luna 20 soil. *Geochim. Cosmochim. Acta*, 37, 1079-1086.
- Tatsumoto M. and Unruh D. M. (1976) KREEP basalt age: Grain by grain U-Th-Pb systematics study of the quartz monzodiorite clast 15405, 88. *Proc. Lunar Sci. Conf. 7th*, pp. 2107-2129.
- Tatsumoto M., Knight R. J., and Doe B. R. (1971) U-Th-Pb systematics of Apollo 12 lunar samples. *Proc. Lunar Sci. Conf. 2nd*, pp. 1521-1546.
- Tatsumoto M., Hedge C. E., Doe B. R., and Unruh D. M. (1972a) U-Th-Pb and Rb-Sr measurements on some Apollo 14 lunar samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1531-1555.
- Tatsumoto M., Hedge C. E., Knight R. J., Unruh D. M., and Doe B. R. (1972b) U-Th-Pb, Rb-Sr, and K measurements on some Apollo 15 and Apollo 16 samples (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 391-395. The Lunar Science Institute, Houston.
- Tatsumoto M., Nunes P. D., Knight R. J., Hedge C. E., and Unruh D. M. (1973) U-Th-Pb, Rb-Sr, and K measurements of two Apollo 17 samples (abstract). *Eos Trans. AGU*, 54, 614-615.
- Tatsumoto M., Premo W. R., and Unruh D. M. (1987) Origin of lead from green glass of Apollo 15426: A search for primitive lunar lead. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E361-E371.
- Taylor D. W. (1937) Stability of earth slopes. *Journal of the Boston Society of Civil Engineers*. Reprinted in *Contributions to Soil Mechanics 1925-1940*, pp. 337-386. Boston Society of Civil Engineers (1940).
- Taylor D. W. (1948) *Fundamentals of Soil Mechanics*. Wiley, New York.
- Taylor G. J. and Spudis P. D. (1990) *Geoscience and a Lunar Base: A Comprehensive Plan for Lunar Exploration*. NASA CP-3070. 73 pp.
- Taylor G. J., Warner R. D., and Keil K. (1978) VLT mare basalts: Impact mixing, parent magma types, and petrogenesis. In *Mare Crisium: The View from Luna 24* (J. J. Papike and R. B. Merrill, eds.), pp. 357-370. Pergamon, New York.
- Taylor G. J., Warner R. D., and Keil K. (1979) Stratigraphy and depositional history of the Apollo 17 drill core. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1159-1184.
- Taylor G. J., Warner R. D., Keil K., Ma M.-S., and Schmitt R. A. (1980) Silicate liquid immiscibility, evolved lunar rocks and the formation of KREEP. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 339-352. Pergamon, New York.
- Taylor H. P. and Epstein S. (1973) O^{18}/O^{16} and Si^{30}/Si^{28} studies of some Apollo 15, 16, and 17 samples. *Proc. Lunar Sci. Conf. 4th*, pp. 1657-1679.
- Taylor L. A. (1988) Generation of native Fe in lunar soil. In *Engineering, Construction, and Operations in Space: Proceedings of Space '88* (S. W. Johnson and J. P. Wetzel, eds.), pp. 67-77. American Society of Civil Engineers, New York.
- Taylor L. A. and Cirlin E.-H. (1986) A review of ESR studies on lunar samples. In *ESR Dating and Dosimetry*, pp. 19-29. Ionics, Tokyo.
- Taylor L. A. and Hunter R. H. (1981) The significance of Cl/P₂O₅ ratios from lunar samples. *Proc. Lunar Planet. Sci. 12B*, pp. 323-331.
- Taylor L. A. and Lu F. (1990) The formation of ore mineral deposits on the Moon: A feasibility study. In *The Second Conference on Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.). Univelt, San Diego, in press.
- Taylor L. A. and McCallister R. H. (1972) Experimental investigation of significance of zirconium partitioning in lunar ilmenite and ulvöspinel. *Earth Planet. Sci. Lett.*, 17, 105-111.
- Taylor L. A. and Williams K. L. (1973) Cu-Fe-S phases in lunar rocks. *Am. Mineral.*, 58, 952-954.
- Taylor L. A., Kullerud G., and Bryan W. B. (1971) Opaque mineralogy and textural features of Apollo 12 samples and a comparison with Apollo 11 rocks. *Proc. Lunar Sci. Conf. 2nd*, pp. 855-871.
- Taylor L. A., Williams R. J., McCallister R. H. (1972) Stability relations of ilmenite and ulvöspinel in the Fe-Ti-O system and application of these data to lunar mineral assemblages. *Earth Planet. Sci. Lett.*, 16, 282-288.
- Taylor L. A., Mao H. K., and Bell P. M. (1973a) "Rust" in the Apollo 16 rocks. *Proc. Lunar Sci. Conf. 4th*, pp. 829-839.

- Taylor L. A., McCallister R. H., and Sardi O. (1973b) Cooling histories of lunar rocks based on opaque mineral geothermometers. *Proc. Lunar Sci. Conf. 4th*, pp. 819–828.
- Taylor L. A., Williams K. L., and Sardi O. (1973c) Selected Apollo 17 soils: Mineralogy and geochemistry of opaque and non-opaque phases. *Earth Planet. Sci. Lett.*, 21, 6–12.
- Taylor L. A., Mao H. K., and Bell P. M. (1974) Identification of the hydrated iron oxide mineral akaganeite in Apollo 16 lunar rocks. *Geology*, 2, 429–432.
- Taylor L. A., Uhlmann D. R., Hopper R. W., and Misra K. C. (1975) Absolute cooling rates of lunar rocks: Theory and application. *Proc. Lunar Sci. Conf. 6th*, pp. 181–191.
- Taylor L. A., Onorato P. I. K., Uhlmann D. R., and Coish R. A. (1978) Subophitic basalts from Mare Crisium: Cooling rates. In *Mare Crisium: The View From Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 473–482. Pergamon, New York.
- Taylor L. A., Shervais J. W., Hunter R. H., Shih D.-Y., Bansal B. M., and Nyquist L. E. (1983) Pre-4.2 AE mare basalt volcanism in the lunar highlands. *Earth Planet. Sci. Lett.*, 66, 33–47.
- Taylor S. R. (1975) *Lunar Science: A Post Apollo View*. Pergamon, New York. 372 pp.
- Taylor S. R. (1982) *Planetary Science: A Lunar Perspective*. Lunar and Planetary Institute, Houston. 481 pp.
- Taylor S. R., Rudowski R., Muir P., Graham A., and Kaye M. (1971) Trace element chemistry of lunar samples from the Ocean of Storms. *Proc. Lunar Sci. Conf. 2nd*, pp. 1083–1099.
- Taylor S. R., Kaye M., Muir P., Nance W., Rudowski R., and Ware N. (1972) Composition of the lunar uplands: Chemistry of Apollo 14 samples from Fra Mauro. *Proc. Lunar Sci. Conf. 3rd*, pp. 1231–1249.
- Taylor S. R., Gorton M. P., Muir P., Nance W., Rudowski R., and Ware N. (1973a) Lunar highlands compositions: Apennine Front. *Proc. Lunar Sci. Conf. 4th*, pp. 1445–1459.
- Taylor S. R., Gorton M. P., Muir P., Nance W. B., Rudowski R., and Ware N. (1973b) Composition of the Descartes region, lunar highlands. *Geochim. Cosmochim. Acta*, 37, 2665–2683.
- Tera F. and Wasserburg G. J. (1972a) U-Th-Pb analyses of soil from the Sea of Fertility. *Earth Planet. Sci. Lett.*, 13, 457–466.
- Tera F. and Wasserburg G. J. (1972b) U-Th-Pb systematics in lunar highland samples from the Luna 20 and Apollo 16 missions. *Earth Planet. Sci. Lett.*, 17, 36–51.
- Tera F. and Wasserburg G. J. (1976) Lunar ball games and other sports (abstract). In *Lunar Science VII*, pp. 858–860. The Lunar Science Institute, Houston.
- Tera F., Eugster O., Burnett D. S., and Wasserburg G. J. (1970) Comparative study of Li, Na, K, Rb, Cs, Ca, Sr, and Ba abundances in achondrites and in Apollo 11 lunar samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1637–1657.
- Tera F., Ray L. A., and Wasserburg G. J. (1972) Distribution of Pb-U-Th in lunar anorthosite 15415 and inferences about its age (abstract). In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 396–401. The Lunar Science Institute, Houston.
- Tera F., Papanastassiou D. A., and Wasserburg G. J. (1974) Isotopic evidence for a terminal lunar cataclysm. *Earth Planet. Sci. Lett.*, 22, 1–21.
- Thiemens M. H. and Clayton R. N. (1980) Solar and cosmogenic nitrogen in the Apollo 17 deep drill core. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1435–1451.
- Thode H. G. and Rees C. E. (1976) Sulphur isotopes in grain size fractions of lunar soils. *Proc. Lunar Sci. Conf. 7th*, pp. 459–468.
- Thompson A. C. and Stevenson D. J. (1983) Two-phase gravitational instabilities in thin disks with application to the origin of the Moon (abstract). In *Lunar and Planetary Science XIV*, pp. 787–788. Lunar and Planetary Institute, Houston.
- Thompson T. W. (1987) High-resolution lunar radar map at 70-cm wavelength. *Earth, Moon and Planets*, 37, 59–70.
- Thompson T. W. (1974) Atlas of lunar radar maps at 70-cm wavelength. *The Moon*, 10, 51–85.
- Thompson T. W. (1979) A review of Earth-based radar mapping of the Moon. *Moon and Planets*, 20, 179–198.
- Thompson T. W. (1986) High resolution radar map of the Moon (abstract). In *Lunar and Planetary Science XVII*, pp. 895–896. Lunar and Planetary Institute, Houston.
- Thompson T. W. and Saunders R. S. (1986) Lunar and Venusian radar bright rings (abstract). In *Lunar and Planetary Science XVII*, pp. 897–898. Lunar and Planetary Institute, Houston.
- Thompson T. W. and Zisk S. H. (1972) Radar mapping of lunar surface roughness. In *Thermal Characteristics of the Moon* (J. W. Lucas, ed.), pp. 83–117. AIAA, New York.
- Thompson T. W., Pollack J. B., Campbell M. J., and O'Leary B. T. (1970) Radar maps of the Moon at 70-cm wavelength and their interpretation. *Radio Sci.*, 5, 253–262.
- Thompson T. W., Howard K. A., Shorthill R. W., Tyler G. L., Sisk S. H., Whitaker E. A., Schaber G. G., and Moore H. J. (1973) Remote sensing of Mare Serenitatis. In *Apollo 17 Preliminary Science Report*, pp. 33–1 to 33–10. NASA SP-330.
- Thompson T. W., Masursky H., Shorthill R. W., Tyler G. L., and Zisk S. H. (1974) A comparison of infrared, radar, and geologic mapping of lunar craters. *The Moon*, 10, 87–117.
- Thompson T. W., Roberts W. J., Hartmann W. K., Shorthill R. W., and Zisk S. H. (1979) Implications about the lunar megaregolith. *Moon and Planets*, 21, 319–342.
- Thompson T. W., Cutts J. A., Shorthill R. W., and Zisk S. H. (1980) Infrared and radar signatures of lunar craters: Implications about crater evolution. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 483–499. Pergamon, New York.
- Tikhonova T. V. and Troitsky V. S. (1969) Effect of heat from within the Moon on its radio emission for the case of lunar properties which vary with depth. *Soviet Astron.*, 13, 120–128.
- Titly S. R. (1966) Seismic energy as an agent of morphologic modification on the Moon. In *Astrogeologic Studies Ann. Prog. Rep. July 1965 July 1966, Pt A*, pp. 87–103. U.S. Geol. Surv. Open File Report.

- Toksoz M. N., Dainty A. M., Solomon S. C., and Anderson K. R. (1973) Velocity structure and evolution of the Moon. *Proc. Lunar Sci. Conf. 4th*, pp. 2529–2547.
- Trask N. J. (1971) Geologic comparison of mare materials in the equatorial belt, including Apollo 11 and 12 landing sites. In *Geological Survey Research 1971*, pp. D138–D144. U.S. Geol. Surv. Prof. Pap. 750–D.
- Trask N. J. (1972) *The Contribution of Ranger Photographs to Understanding the Geology of the Moon*. U.S. Geol. Surv. Prof. Pap. 599–I. 16 pp.
- Tsay F.-D., Chan S. I., and Manatt S. L. (1971) Ferromagnetic resonance of lunar samples. *Geochim. Cosmochim. Acta*, 5, 865–875.
- Tsay F.-D., Manatt S. L., Live D. H., and Chan S. J. (1973) Metallic Fe phases in Apollo 16 fines: Their origin and characteristics as revealed by electron spin resonance studies. *Proc. Lunar Sci. Conf. 4th*, pp. 2751–2761.
- Tucker D. S., Vaniman D. T., Anderson J. L., Clinard F. W. Jr., Feber R. C. Jr., Frost H. M., Meek T. T., and Wallace T. C. (1985) Hydrogen recovery from extraterrestrial materials using microwave energy. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 583–590. Lunar and Planetary Institute, Houston.
- Tucker M. E. (1981) *Sedimentary Petrology*. Blackwell, Oxford. 252 pp.
- Turekian K. K. and Kharkar D. P. (1970) Neutron activation analysis of milligram quantities of Apollo 11 lunar rocks and soil. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1659–1664.
- Turner G. and Cadogan P. H. (1975) The history of lunar bombardment inferred from ^{40}Ar - ^{39}Ar dating of highland rocks. *Proc. Lunar Sci. Conf. 6th*, pp. 1509–1538.
- Turner G., Cadogan P. H., and Yonge C. J. (1973) Argon selenochronology. *Proc. Lunar Sci. Conf. 4th*, pp. 1889–1914.
- Tyler G. L. (1968a) Brewster angle of the lunar crust. *Nature*, 219, 1243–1244.
- Tyler G. L. (1968b) Oblique-scattering radar reflectivity of the lunar surface: Preliminary results from Explorer 35. *J. Geophys. Res.*, 73, 7609–7620.
- Tyler G. L. (1979) Comparison of quasi-specular radar scatter from the Moon with surface parameters obtained from images. *Icarus*, 37, 29–45.
- Tyler G. L. and Howard H. T. (1973) Dual-frequency bistatic-radar investigations of the Moon with Apollos 14 and 15. *J. Geophys. Res.*, 78, 4852–4874.
- Tyler G. L., Simpson R. A., and Moore H. J. (1971) Lunar slope distributions, comparison of bistatic-radar and photographic results. *J. Geophys. Res.*, 76, 2790–2795.
- Uhlmann D. R., Klein L., Kritchevsky G., and Hopper R. W. (1974) The formation of lunar glasses. *Proc. Lunar Sci. Conf. 5th*, pp. 2317–2331.
- Uhlmann D. R., Onorato P. I. K., Yinnon H., and Taylor L. A. (1979) Partitioning as a cooling rate indicator (abstract). In *Lunar and Planetary Science X*, pp. 1253–1255. Lunar and Planetary Institute, Houston.
- Ulaby F. T., Moore R. K., and Fung A. K., eds. (1982) *Microwave Remote Sensing Vol. 2: Surface Scattering and Emission Theory*. Addison-Wesley, Reading. 1064 pp.
- Ulich B. L., Cogdell J. R., Davis J. H., and Calvert T. A. (1974) Observations and analysis of lunar radio emission at 3.09 mm wavelength. *The Moon*, 10, 163–174.
- Ullrich G. W., Roddy D. J., and Simmons G. (1977) Numerical simulations of a 20-ton TNT detonation at the earth's surface and implications concerning the mechanics of central uplift formation. In *Impact and Explosion Cratering* (D. J. Roddy, R. O. Pepin, and R. B. Merrill, eds.), pp. 959–982. Pergamon, New York.
- Ulrich G. E., Hodges C. A., and Muehlberger W. R., eds. (1981) *Geology of the Apollo 16 Area, Central Lunar Highlands*. U.S. Geol. Surv. Prof. Pap. 1048. 539 pp.
- Unruh D. M. and Tatsumoto M. (1978) Implications from Luna 24 sample 24170 to U-Pb evolution of the lunar mantle. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 679–694. Pergamon, New York.
- Unruh D. M., Nakamura N., and Tatsumoto M. (1977) History of the Pasamonte achondrite: Relative susceptibility of the Sm-Nd, Rb-Sr, and U-Pb systems to metamorphic events. *Earth Planet. Sci. Lett.*, 37, 1–12.
- Urey H. C. (1965) Meteorites and the Moon. *Science*, 147, 1262–1265.
- Urey H. C. (1966) The capture hypothesis of the origin of the Moon. In *The Earth-Moon System* (B. G. Marsden and A. G. W. Cameron, eds.), pp. 210–212. Plenum, New York.
- Usselman T. M. and Lofgren G. E. (1976) The phase relations, textures, and mineral chemistries of high titanium mare basalts as a function of oxygen fugacity and cooling rate. *Proc. Lunar Sci. Conf. 7th*, pp. 1345–1363.
- Usselman T. M. and Pearce G. W. (1974) Grain growth of iron: Implications for the thermal conditions in a lunar ejecta blanket (abstract). In *Lunar Science V*, pp. 809–811. The Lunar Science Institute, Houston.
- Usselman T. M., Lofgren G. E., Donaldson C. H., and Williams R. J. (1975) Experimentally reproduced textures and mineral chemistries of high-titanium mare basalts. *Proc. Lunar Sci. Conf. 6th*, pp. 997–1020.
- van Diggelen J. (1959) Photometric properties of lunar crater floors. *Recherches Astronomiques de l'Observatoire d'Utrecht*, 14, no. 2. Translated to English as NASA Technical Translation F-209 (1964).
- Van Hollebeke M. A. I., Ma Sung L. S., and McDonald F. B. (1975) The variation of solar proton energy spectra and size distribution with heliolongitude. *Solar Phys.*, 41, 189–223.
- Vaniman D. T. (1990) Glass variants and multiple HASP trends in Apollo 14 regolith breccias. *Proc. Lunar Planet. Sci. Conf. 20th*, pp. 209–217.
- Vaniman D. T. and Bish D. L. (1990) Yoshiokaite, a new Ca,Al-silicate mineral from the Moon. *Am. Mineral.*, 75, 676–686.
- Vaniman D. T. and Papike J. J. (1977a) The Apollo 17 drill core: Characterization of the mineral and lithic component (sections 70007, 70008, 70009). *Proc. Lunar Sci. Conf. 8th*, pp. 3123–3159.

- Vaniman D. T. and Papike J. J. (1977b) The Apollo 17 drill core: Modal petrology and glass chemistry (sections 70007, 70008, 70009). *Proc. Lunar Sci. Conf. 8th*, 3161–3193.
- Vaniman D. T. and Papike J. J. (1977c) Very low Ti (VLT) basalts: A new mare rock type from the Apollo 17 drill core. *Proc. Lunar Sci. Conf. 8th*, pp. 1443–1471.
- Vaniman D. T. and Papike J. J. (1980) Lunar highland melt rocks: Chemistry petrology and silicate mineralogy. In *Proceedings of the Conference on the Lunar Highlands Crust* (J. J. Papike and R. B. Merrill, eds.), pp. 271–337. Pergamon, New York.
- Vaniman D. T., Lellis S. F., Papike J. J., and Cameron K. L. (1976) The Apollo 16 drill core: Modal petrology and characterization of the mineral and lithic component. *Proc. Lunar Sci. Conf. 7th*, pp. 199–239.
- Vaniman D. T., Labotka T. C., Papike J. J., Simon S. B., and Laul J. C. (1979) The Apollo 17 drill core: Petrologic systematics and the identification of a possible Tycho component. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1185–1227.
- Vaniman D. T., Meek T. T., and Blake R. D. (1986) Fusing of lunar materials with microwave energy; Pt. II. Melting of a simulated glassy Apollo 11 soil (abstract). In *Lunar and Planetary Science XVII*, pp. 911–912. Lunar and Planetary Institute, Houston.
- Vaniman D., Pettit D., and Heiken G. (1990) Uses of lunar sulfur. In *The Second Conference on Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.). Univelt, San Diego, in press.
- Vanyan L. L., Vnuchlkova T. A., Egorov I. V., Basilevsky A. T., Eroshenko E. G., Fainberg E. B., Dyal P., and Daily W. D. (1979) Electrical conductivity anomaly beneath Mare Serenitatis detected by Lunokhod 2 and Apollo 16 magnetometers. *Moon and Planets*, 21, 185–192.
- Vedder J. F. and Mandeville J.-C. (1974) Microcraters formed in glasses by projectiles of various densities. *J. Geophys. Res.*, 79, 3247–3256.
- Vedenin A. I., Douchowskoy E. A., Markatchev V. V., Silin A. A., Cherkasov I. I., and Shvarev V. V. (1974) The investigation of mechanical properties of lunar soil and its analogs in different atmospheres and vacuum in the TOR-1 installation. In *Lunar Soil from Sea of Fertility*, pp. 571–581. Nauka, Moscow (in Russian).
- Verkouteren R. M., Dennison J. E., and Lipschutz M. E. (1983) Siderophile, lithophile and mobile trace elements in the lunar meteorite Allan Hills 81005. *Geophys. Res. Lett.*, 10, 821–824.
- Veverka J. and Noland M. (1973) Asteroid reflectivities from polarization curves: Calibration of the “slope-albedo” relationship. *Icarus*, 19, 230–239.
- Vinogradov A. P. (1971) Preliminary data on lunar ground brought to Earth by automatic probe “Luna-16.” *Proc. Lunar Sci. Conf. 2nd*, pp. 1–16.
- Vinogradov A. P. (1972) Preliminary data on lunar regolith returned by automatic probe “Luna-20.” *Geokhimiya*, 7, 763–774.
- Vinogradov A. P. (1973) Preliminary data on lunar soil collected by the Luna 20 unmanned spacecraft. *Geochim. Cosmochim. Acta*, 37, 721–729.
- Vondrak R. R. (1974) Creation of an artificial lunar atmosphere. *Nature*, 248, 657–659.
- von Engelhardt W. V., Luft E., Arndt J., Shock H., and Weiskichner W. (1987) Origin of moldavites. *Geochim. Cosmochim. Acta*, 51, 1425–1443.
- von Gunten H. R., Wegmuller F., and Krähenbühl U. (1982) Low temperature volatilization on the Moon. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 87, A279–A282.
- Wadell H. (1935) Volume, shape and roundness of quartz particles. *J. Geol.*, 43, 250–280.
- Wakita H., Schmitt R. A., and Rey P. (1970) Elemental abundances of major, minor and trace elements in Apollo 11 lunar rocks, soil and core samples. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1685–1717.
- Wakita H., Rey P., and Schmitt R. A. (1971) Abundances of the 14 rare-earth elements and 12 other trace elements in Apollo 12 samples—five igneous and one breccia rocks and four soils. *Proc. Lunar Sci. Conf. 2nd*, pp. 1319–1330.
- Waldron R. D. (1990) Alternatives for *in situ* resource processing. In *Engineering Construction, and Operations in Space II: Proceedings of Space '90* (S. W. Johnson and J. P. Wetzel, eds.), pp. 216–225. American Society of Civil Engineers, New York.
- Walker D. (1983) Lunar and terrestrial crust formation. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B17–B25.
- Walker D., Longhi J., and Hays J. F. (1972) Experimental petrology and origin of Fra Mauro rocks and soil. *Proc. Lunar Sci. Conf. 3rd*, pp. 797–817.
- Walker D., Longhi J., Grove T. L., Stolper E., and Hays J. F. (1973a) Experimental petrology and origin of rocks from the Descartes highlands. *Proc. Lunar Sci. Conf. 4th*, pp. 1013–1032.
- Walker D., Grove T. L., Longhi J., Stolper E. M., and Hays J. F. (1973b) Origin of lunar feldspathic rocks. *Earth Planet. Sci. Lett.*, 20, 325–336.
- Walker D., Longhi J., Stolper E. M., Grove T. L., and Hays J. F. (1975) Origin of titaniferous lunar basalts. *Geochim. Cosmochim. Acta*, 39, 1219–1235.
- Walker D., Kirkpatrick R. J., Longhi J., and Hays J. F. (1976) Crystallization history of lunar picritic basalt sample 12002: Phase equilibria and cooling rate studies. *Geol. Soc. Am. Bull.*, 87, 646–656.
- Walker D., Longhi J., Lasaga A. C., Stolper E. M., Grove T. L., and Hays J. F. (1977) Slowly cooled microgabbros 15555 and 15065. *Proc. Lunar Sci. Conf. 8th*, pp. 1521–1547.
- Walker D., Powell M. A., Lofgren G. E., and Hays J. F. (1978) Dynamic crystallization of a eucrite basalt. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 1369–1391.
- Walker R. J. and Papike J. J. (1981) The relationship of the lunar regolith <10 mm fraction and agglutinates. Part II: Chemical composition of agglutinate glass as a test of the “fusion of the finest fraction” (F³) model. *Proc. Lunar Planet. Sci. 12B*, pp. 421–431.

- Walker R. M. (1975) Interaction of energetic nuclear particles in space with the lunar surface. *Annu. Rev. Earth Planet. Sci.*, 3, 99–128.
- Walker R. M. (1980) Nature of the fossil evidence: Moon and meteorites. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 11–28. Pergamon, New York.
- Walker R. and Yuhas D. (1973) Cosmic ray track production rates in lunar materials. *Proc. Lunar Sci. Conf. 4th*, pp. 2379–2389.
- Walton J. R., Lakatos S., and Heymann D. (1973) Distribution of inert gases in fines from the Cayley-Descartes region. *Proc. Lunar Sci. Conf. 4th*, pp. 2079–2095.
- Wänke H., Rieder R., Baddenhausen H., Spettel B., Teschke Quijano-Rico M., and Basacescu A. (1970a) Major and trace elements in lunar materials. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1719–1727.
- Wänke H., Wlotzka F., Jagoutz E., and Begemann F. (1970b) Composition and structure of metallic iron particles in lunar fines. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 931–936.
- Wänke H., Wlotzka F., Baddenhausen H., Balacescu A., Spettel B., Teschke F., Jagoutz E., Kruse H., Quijano-Rico M., and Rieder R. (1971) Apollo 12 samples: Chemical composition and its relation to sample locations and exposure ages, the two component origin of the various soil samples and studies on lunar metallic particles. *Proc. Lunar Sci. Conf. 2nd*, pp. 1187–1208.
- Wänke H., Baddenhausen H., Balacescu A., Teschke F., Spettel B., Dreibus G., Palme H., Quijano-Rico M., Kruse H., Wlotzka F., and Begemann F. (1972) Multielement analyses of lunar samples and some implications of the results. *Proc. Lunar Sci. Conf. 3rd*, pp. 1251–1268.
- Wänke H., Baddenhausen H., Dreibus G., Jagowitz E., Kruse H., Palme H., Spettel B., and Teschke F. (1973) Multielement analyses of Apollo 15, 16, and 17 samples and the bulk composition of the Moon. *Proc. Lunar Sci. Conf. 4th*, pp. 1461–1481.
- Wänke H., Palme H., Baddenhausen H., Dreibus G., Jagoutz E., Kruse H., Spettel B., Teschke F., and Thacker R. (1974) Chemistry of Apollo 16 and 17 samples: Bulk composition, late stage accumulation and early differentiation of the Moon. *Proc. Lunar Sci. Conf. 5th*, pp. 1307–1335.
- Wänke H., Palme H., Baddenhausen H., Dreibus G., Jagoutz E., Kruse H., Palme C., Spettel B., Teschke F., and Thacker R. (1975) New data on the chemistry of lunar samples: Primary matter in the lunar highlands and the bulk composition of the Moon. *Proc. Lunar Sci. Conf. 6th*, pp. 1313–1340.
- Wänke H., Palme H., Kruse H., Baddenhausen H., Cendales M., Dreibus G., Hofmeister H., Jagoutz E., Palme C., Spettel B., and Thacker R. (1976) Chemistry of lunar highland rocks: A refined evaluation of the composition of the primary matter. *Proc. Lunar Sci. Conf. 7th*, pp. 3479–3499.
- Wänke H., Baddenhausen H., Blum K., Cendales M., Dreibus Hofmeister H., Kruse H., Jagoutz E., Palme C., Spettel B., Thacker R., and Vilček E. (1977) On the chemistry of lunar samples and achondrites. Primary matter in the lunar highlands: A re-evaluation. *Proc. Lunar Sci. Conf. 8th*, pp. 2191–2213.
- Wänke H., Dreibus G., and Palme H. (1978) Primary matter in the lunar highlands: The case of siderophile elements. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 83–110.
- Warhaut M., Kiko J., and Kirsten T. (1979) Microdistribution patterns of implanted rare gases in a large number of individual lunar soil particles. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 1531–1546.
- Warner J. L. (1970) *Apollo 12 Lunar Sample Information*. NASA TR-R-353. 391 pp.
- Warner J. L. (1971) Lunar crystalline rocks: Petrology and geology. *Proc. Lunar Sci. Conf. 2nd*, pp. 469–480.
- Warner J. L. (1972) Metamorphism of Apollo 14 breccias. *Proc. Lunar Sci. Conf. 3rd*, pp. 623–643.
- Warner J. L., Simonds C. H., and Phinney W. C. (1973) Apollo 16 rocks: Classification and petrogenetic model. *Proc. Lunar Sci. Conf. 4th*, pp. 481–504.
- Warner J. L., Simonds C. H., and Phinney W. C. (1976a) Genetic distinction between anorthosites and Mg-rich plutonic rocks: New data from 76255 (abstract). In *Lunar Science VII*, pp. 915–917. The Lunar Science Institute, Houston.
- Warner J. L., Simonds C. H., and Phinney W. C. (1976b) Apollo 17, Station 6 boulder sample 76255: Absolute petrology of breccia matrix and igneous clasts. *Proc. Lunar Sci. Conf. 7th*, pp. 2233–2250.
- Warner J. L., Phinney W. C., Bickel C. E., and Simonds C. H. (1977) Feldspathic granulitic impactites and pre-final bombardment lunar evolution. *Proc. Lunar Sci. Conf. 8th*, pp. 2051–2066.
- Warner R. D., Planner H. N., Keil K., Murali A. V., Ma M.-S., Schmitt R. A., Ehmman W. D., James W. D. Jr., Clayton R. N., and Mayeda T. K. (1976a) Consortium investigation of breccia 67435. *Proc. Lunar Sci. Conf. 7th*, pp. 2379–2402.
- Warner R. D., Barkley J. L., Manaker W. L., Warren R. G., and Keil K. (1976b) *Electron Microprobe Analyses of Spinel, Fe Oxides, and Metal from Apollo 17 Rake Sample Mare Basalts*. Inst. of Meteoritics Spec. Publ. 16, Univ. of New Mexico, Albuquerque. 114 pp.
- Warner R. D., Keil K., Nehru C. E., and Taylor G. J. (1976c) *Catalogue of Apollo 16 Rake Samples from the LM area and Station 5*. Inst. of Meteoritics Spec. Publ. 13, Univ. of New Mexico, Albuquerque. 87 pp.
- Warner R. D., Keil K., Nehru C. E., and Taylor G. J. (1978a) *Catalogue of Apollo 17 Rake Samples from Stations 1A, 2, 7 and 8*. Inst. of Meteoritics Spec. Publ. 18, Univ. of New Mexico, Albuquerque. 88 pp.
- Warner R. D., Nehru C. E., and Keil K. (1978b) Opaque oxide mineral crystallization in lunar high-titanium mare basalts. *Am. Mineral.*, 63, 1209–1224.
- Warner R. D., Taylor G. J., Conrad G. H., Northrop H. R., Barker S., and Keil K. (1979a) Apollo 17 high-Ti mare basalts: New bulk compositional data, magma types, and petrogenesis. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 225–247.

- Warner R. D., Taylor G. J., Wentworth S. J., Huss G. R., Mansker W. L., Planner H. N., Sayeed U. A., and Keil K. (1979b) *Electron Microprobe Analyses of Glasses from Apollo 17 Rake Sample Breccias and Apollo 17 Drill Core*. Inst. of Meteoritics Spec. Publ. 20, Univ. of New Mexico, Albuquerque. 20 pp.
- Warren P. H. (1985) The magma ocean concept and lunar evolution. *Annu. Rev. Earth Planet. Sci.*, 13, 201–240.
- Warren P. H. (1986) Anorthosite assimilation and the origin of the Mg/Fe-related bimodality of pristine Moon rocks: Support for the magmasphere hypothesis. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D331–D343.
- Warren P. H. and Jerde E. (1987) Composition and origin of Nuevo Laredo Trend eucrites. *Geochim. Cosmochim. Acta*, 51, 713–725.
- Warren P. H. and Kallemeyn G. W. (1984) Pristine rocks (8th foray): “Plagiophile” element ratios, crustal genesis, and the bulk composition of the moon. *Proc. Lunar Planet. Sci. Conf. 15th*, in *J. Geophys. Res.*, 89, C16–C24.
- Warren P. H. and Kallemeyn G. (1986) Geochemistry of lunar meteorite Yamato-791197: Comparison with ALHA81005 and other lunar samples. *Proceedings of the Tenth Symposium on Antarctic Meteorites*, pp. 3–16. Natl. Inst. for Polar Res., Tokyo.
- Warren P. H. and Kallemeyn G. W. (1987) Major elements and trace siderophile elements in four lunar meteorites. *Proceedings of the Eleventh Symposium on Antarctic Meteorites*, pp. 1–20. Natl. Inst. for Polar Res., Tokyo.
- Warren P. H. and Taylor G. J. (1981) Geochemical constraints on lateral transport during basin formation (abstract). In *Workshop on Apollo 16* (O. B. James and F. Hörz, eds.), pp. 147–149. LPI Tech. Rpt. 81–01, Lunar and Planetary Institute, Houston.
- Warren P. H. and Wasson J. T. (1977) Pristine nonmare rocks and the nature of the lunar crust. *Proc. Lunar Sci. Conf. 8th*, pp. 2215–2235.
- Warren P. H. and Wasson J. T. (1978) Compositional-petrographic investigation of pristine nonmare rocks. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 185–217.
- Warren P. H. and Wasson J. T. (1979a) The origin of KREEP. *Rev. Geophys. Space Phys.*, 17, 73–88.
- Warren P. H. and Wasson J. T. (1979b) The compositional-petrographic search for pristine nonmare rocks: Third foray. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 583–610.
- Warren P. H. and Wasson J. T. (1980) Further foraging for pristine nonmare rocks: Correlations between geochemistry and longitude. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 431–470.
- Warren P. H., Afiatalab F., and Wasson J. T. (1978) Investigation of unusual KREEPy samples: Pristine rock 15386, Cone Crater soil fragments 14143, and 12023, a typical Apollo-12 soil. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 653–660.
- Warren P. H., Taylor G. J., Keil K., Marshall C., and Wasson J. T. (1981) Foraging westward for pristine nonmare rocks: Complications for petrogenetic models. *Proc. Lunar Planet. Sci. 12B*, pp. 21–40.
- Warren P. H., Taylor G. J., Keil K., Kallemeyn G. W., Rosener P. S., and Wasson J. T. (1983a) Sixth foray for pristine nonmare rocks and an assessment of the diversity of lunar anorthosites. *Proc. Lunar Planet. Sci. Conf. 13th*, in *J. Geophys. Res.*, 88, A615–A630.
- Warren P. H., Taylor G. J., Keil K., Shirley D. N., and Wasson J. T. (1983b) Petrology and chemistry of two “large” granite clasts from the Moon. *Earth Planet. Sci. Lett.*, 64, 175–185.
- Warren P. H., Taylor G. J., Keil K., Kallemeyn G. W., Shirley D. N., and Wasson J. T. (1983c) Seventh foray: Whitlockite-rich lithologies, a diopside-bearing troctolitic anorthosite, ferroan anorthosites, and KREEP. *Proc. Lunar Planet. Sci. Conf. 14th*, in *J. Geophys. Res.*, 88, B151–B164.
- Warren P. H., Taylor G. J., and Keil K. (1983d) Regolith breccia Allan Hills A81005: Evidence of lunar origin, and petrography of pristine and nonpristine clasts. *Geophys. Res. Lett.*, 10, 779–782.
- Warren P. H., Shirley D. N., and Kallemeyn G. W. (1986) A potpourri of pristine Moon rocks, including a VHK mare basalt and a unique, augite-rich Apollo 17 anorthosite. *Proc. Lunar Planet. Sci. Conf. 16th*, in *J. Geophys. Res.*, 91, D319–D330.
- Warren P. H., Jerde E., and Kallemeyn G. W. (1987) Pristine moon rocks: A “large” felsite and a metal-rich ferroan anorthosite. *Proc. Lunar Planet. Sci. Conf. 17th*, in *J. Geophys. Res.*, 92, E303–E313.
- Warren P. H., Jerde E. A., and Kallemeyn G. W. (1989) Lunar meteorites: Siderophile element contents, and implications for the composition and origin of the Moon. *Earth Planet. Sci. Lett.*, 91, 245–260.
- Wasserburg G. J. and Papanastassiou D. A. (1971) Age of Apollo 15 mare basalt: Lunar crust and mantle evolution. *Earth Planet. Sci. Lett.*, 13, 97–104.
- Wasserburg G. J., Papanastassiou D. A., Tera F., and Huneke J. C. (1977) Outline of a lunar chronology. *Philos. Trans. R. Soc. London*, A285, 7–22.
- Wasson J. T. (1985) *Meteorites: Their Record of Early Solar-System History*. Freeman, New York. 267 pp.
- Wasson J. T. and Baedeker P. A. (1970) Ga, Ge, In, Ir and Au in lunar, terrestrial and meteoritic basalts. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 1741–1750.
- Wasson J. T., Chou C.-L., Bild R. W., and Baedeker P. A. (1973) Extralunar materials in Cone-Crater soil 14141. *Geochim. Cosmochim. Acta*, 37, 2349–2353.
- Wasson J. T., Chou C.-L., Robinson K. L., and Baedeker P. A. (1975a) Siderophiles and volatiles in Apollo-16 rocks and soils. *Geochim. Cosmochim. Acta*, 39, 1475–1485.
- Wasson J. T., Boynton W. V., Chou C.-L., and Baedeker P. A. (1975b) Compositional evidence regarding the influx of interplanetary materials onto the lunar surface. *The Moon*, 13, 121–141.
- Wasson J. T., Boynton W. V., Kallemeyn G. W., Sundberg L. L., and Wai C. M. (1976) Volatile compounds released during lunar lava fountaining. *Proc. Lunar Sci. Conf. 7th*, pp. 1583–1595.
- Wasson J. T., Warren P. H., Kallemeyn G. W., McEwing C. E., Mittlefehldt D. W., and Boynton W. V. (1977) SCCR, a

- major component of highlands rocks. *Proc. Lunar Sci. Conf. 8th*, pp. 2237–2252.
- Watkins J. S. and Kovach R. L. (1973) Seismic investigation of the lunar regolith. *Proc. Lunar Sci. Conf. 4th*, pp. 2561–2574.
- Watson E. B. and Green T. H. (1981) Apatite/liquid partition coefficients for the rare earth elements and strontium. *Earth Planet. Sci. Lett.*, 56, 405–421.
- Wechsler A. E. and Glaser P. E. (1965) Pressure effects on postulated lunar materials. *Icarus*, 4, 335–352.
- Wechsler B. A. and Prewitt C. T. (1977) Structural chemistry of armalcolite and ilmenite at high temperatures (abstract). In *Lunar Science VIII*, pp. 1000–1001. The Lunar Science Institute, Houston.
- Wechsler B. A., Prewitt C. T., and Papike J. J. (1976) Chemistry and structure of lunar and synthetic armalcolite. *Earth Planet. Sci. Lett.*, 29, 91–103.
- Weigand P. W. (1972) Petrology of pyroxene vitrophyre 15597. In *The Apollo 15 Lunar Samples* (J. W. Chamberlain and C. Watkins, eds.), pp. 187–188. The Lunar Science Institute, Houston.
- Weigand P. W. and Hollister L. S. (1973) Basaltic vitrophyre 15597: An undifferentiated melt sample. *Earth Planet. Sci. Lett.*, 19, 61–74.
- Weill D. F. and McKay G. A. (1975) The partitioning of Mg, Fe, Sr, Ce, Sm, Eu and Yb in lunar igneous systems and a possible origin of KREEP by equilibrium partial melting. *Proc. Lunar Sci. Conf. 6th*, pp. 1143–1158.
- Weill D. F., Grieve R. A., McCallum I. S., and Bottinga Y. (1971) Mineralogy-petrology of lunar samples: Micro-probe studies of samples 12021 and 12022; Viscosity of melts of selected lunar compositions. *Proc. Lunar Sci. Conf. 2nd*, pp. 413–430.
- Weismann P. R. (1982) Terrestrial impact rates for long and short-period comets. In *Geological Implications of Impacts of Large Asteroids and Comets on the Earth* (L. T. Silver and P. H. Schultz, eds.), pp. 15–24. Geol. Soc. Am. Spec. Pap. 190.
- Wenk H. R. and Wilde W. R. (1973) Chemical anomalies of lunar plagioclase, described by substitution vectors and their relation to optical and structural properties. *Contrib. Mineral. Petrol.*, 41, 89–104.
- Wentworth S., Taylor G. J., Warner R. D., Keil K., Ma M.-S., and Schmitt R. A. (1979) The unique nature of Apollo 17 VLT mare basalts. *Proc. Lunar Planet. Sci. Conf. 10th*, pp. 207–232.
- Wetherill G. W. (1977) Evolution of the Earth's planetesimal swarm subsequent to the formation of the Earth and Moon. *Proc. Lunar Sci. Conf. 8th*, pp. 1–16.
- Wetherill G. W. (1981) Nature and origin of basin-forming projectiles. In *Multi-Ring Basins*, *Proc. Lunar Planet. Sci. 12A* (P. H. Schultz and R. B. Merrill, eds.), pp. 1–18. Pergamon, New York.
- Whipple E. C. (1981) Potentials of surfaces in space. *Rep. Progr. Phys.*, 44, 1197–1250.
- Whipple F. L. (1963) On meteoroids and penetration. *Geophys. Res.*, 68, 4929–4939.
- Whitaker E. A. (1972) Lunar color boundaries and their relationship to topographic features: A preliminary survey. *The Moon*, 4, 348–355.
- White D. C. and Hirsch P. (1985) Microbial extraction of hydrogen from lunar dust. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 591–602. Lunar and Planetary Institute, Houston.
- Wieler R., Etique P., Signer P., and Poupeau G. (1980) Record of the solar corpuscular radiation in minerals from lunar soils: A comparative study in noble gases and tracks. *Proc. Lunar Planet. Sci. Conf. 11th*, pp. 1369–1393.
- Wiesmann H. and Hubbard N. J. (1975) *A Compilation of the Lunar Sample Data Generated by the Gast Nyquist and Hubbard Lunar Sample PI Ships*. NASA Johnson Space Center, Houston. 50 pp.
- Willey R. L. (1978) The Moon in heiligenschein. *Science*, 200, 1265–1267.
- Willey R. L. and Pohn H. A. (1964) Detailed photoelectric photometry of the Moon. *Astron. J.*, 69, 619–634.
- Willey R. L. and Pohn H. A. (1969) The normal albedo of the Apollo 11 landing site and intrinsic dispersion on the lunar heiligenschein. *Astrophys. J.*, 158, L129–L130.
- Wilhelms D. E. (1970) *Summary of Lunar Stratigraphy—Telescopic Observations*. U.S. Geol. Surv. Prof. Pap. 599–F. 47 pp.
- Wilhelms D. E. (1972) *Geologic Mapping of the Second Planet*. U.S. Geol. Surv. Open File Rept., Astrogeologic Studies 55. 36 pp.
- Wilhelms D. E. (1984) The Moon. In *The Geology of the Terrestrial Planets* (M. Carr et al., eds.), pp. 107–205. NASA SP-469.
- Wilhelms D. E. (1987) *The Geologic History of the Moon*. U.S. Geol. Surv. Prof. Pap. 1348. 302 pp.
- Wilhelms D. E. and Davis D. E. (1971) Two former faces of the Moon. *Icarus*, 15, 368–372.
- Wilhelms D. E. and El Baz F. (1977) Geologic map of the east side of the Moon. *U.S. Geol. Surv. Map I-948*, scale 1:5,000,000.
- Wilhelms D. E. and McCauley J. F. (1971) Geologic map of the nearside of the Moon. *U.S. Geol. Surv. Map I-703*.
- Wilhelms D. E., Oberbeck U. R., and Aggarwal H. R. (1978) Size-frequency distributions of primary and secondary lunar impact craters. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 3735–3762.
- Wilhelms D. E., Howard K. A., and Wilshire H. G. (1979) Geologic map of the south side of the Moon. *U.S. Geol. Surv. Map I-1162*.
- Wilkening L., ed. (1982) *Comets*. Univ. of Arizona, Tucson. 76 pp.
- Williams G. J. (1974) Electrostatic migration, surface exposure and layering. In *Lunar Interactions* (D. R. Criswell and J. R. Freeman, eds.), pp. 55–56. The Lunar Science Institute, Houston.
- Williams K. L. and Taylor L. A. (1974) Optical properties and chemical compositions of Apollo 17 armalcolites. *Geology*, 2, 5–8.
- Williams R. J. (1985) Oxygen extraction from lunar materials: An experimental test of an ilmenite reduction

- process. In *Lunar Bases and Space Activities of the 21st Century* (W. W. Mendell, ed.), pp. 551–558. Lunar and Planetary Institute, Houston.
- Williams R. J. and Erstfeld T. E. (1979) *High Temperature Electrolyte Recovery of Oxygen from Gaseous Effluents from the Carbo-Chlorination of Lunar Anorthite and the Hydrogenation of Ilmenite*. NASA TM-58214. 51 pp.
- Williams R. J. and Jadwick J. J. (1980) *Handbook of Lunar Materials*. NASA RP-1057. 120 pp.
- Williams R. J., McKay D. S., Giles D., and Bunch T. E. (1979) Mining and beneficiation of lunar ores. In *Space Resources and Space Settlements*, pp. 275–288. NASA SP-428.
- Willis J. P., Ahrens L. H., Danchin R. V., Erlank A. J., Gurney J. J., Hofmeyr P. K., McCarthy T. S., and Orren M. J. (1971) Some interelement relationships between lunar rocks and fines and stony meteorites. *Proc. Lunar Sci. Conf. 2nd*, pp. 1123–1138.
- Willis J. P., Erlank A. J., Gurney J. J., Theil R. H., and Ahrens L. H. (1972) Major, minor, and trace element data for some Apollo 11, 12, 14, and 15 samples. *Proc. Lunar Sci. Conf. 3rd*, pp. 1269–1273.
- Wilshire H. G. and Howard K. A. (1968) Structural pattern in central uplifts of cryptoexplosion structures as typified by Sierra Madera. *Science*, 162, 258–261.
- Wilshire H. G. and Jackson E. D. (1972) *Petrology and Stratigraphy of the Fra Mauro Formation at the Apollo 14 Site*. U.S. Geol. Surv. Prof. Pap. 785. 26 pp.
- Winter D. F. (1970) The infrared Moon: Data, interpretations, and implications. *Radio Sci.*, 5, 229–240.
- Winzer S. R., Nava D. F., Schumann S., Kouns C. W., Lum R. K. L., and Philpotts J. (1974) Major, minor and trace element abundances in samples from the Apollo 17 Station 7 boulder: Implications for the origin of early lunar crustal rocks. *Earth Planet. Sci. Lett.*, 23, 439–444.
- Wise D. U. and Yates M. T. (1970) Mascons as structural relief on a lunar “moho.” *J. Geophys. Res.*, 75, 261–268.
- Wiskerchen M. J. and Sonett C. P. (1977) A lunar metal core? *Proc. Lunar Sci. Conf. 8th*, pp. 515–535.
- Wittenberg L. J., Santarius J. F., and Kulcinski G. L. (1987) Lunar source of ^3He for commercial fusion power. *Fusion Technol.*, 10, 167–178.
- Wlotzka F., Jagouz E., Spettel B., Baddenhausen H., Balacescu A., and Wänke H. (1972) On lunar metallic particles and their contribution to the trace element content of Apollo 14 and 15 soils. *Proc. Lunar Sci. Conf. 3rd*, pp. 1077–1084.
- Wlotzka F., Spettel B., and Wänke H. (1973) On the composition of metal from Apollo 16 fines and the meteoritic component. *Proc. Lunar Sci. Conf. 4th*, pp. 1483–1491.
- Wolf R. and Anders E. (1980) Moon and Earth: Compositional differences inferred from siderophiles, volatiles, and alkalis in basalts. *Geochim. Cosmochim. Acta*, 44, 2111–2124.
- Wolf R., Woodrow A., and Anders E. (1979) Siderophile and volatile elements in the Earth and Moon: Similar or not (abstract). In *Lunar and Planetary Science X*, pp. 1361–1363. Lunar and Planetary Institute, Houston.
- Wolfe E. W., Bailey N. G., Lucchitta B. K., Muehlberger W. R., Scott D. H., Sutton R. L., and Wilshire H. G. (1981) *The Geologic Investigation of the Taurus-Littrow Valley: Apollo 11 Landing Site*. U.S. Geol. Surv. Prof. Pap. 1080. 280 pp.
- Wolfe S. H. (1971) Potassium-argon ages of the Manicouagan-Mushalagan structure, Quebec, Canada. *J. Geophys. Res.*, 76, 5424–5436.
- Wood C. A. and Andersson L. (1978) *The Lunar and Planetary Laboratory Catalog of Lunar Craters, Pt. 1: Nearside*. Unpublished manuscript.
- Wood J. A., Dickey J. S., Marvin U. B., and Powell B. N. (1970) Lunar anorthosites and a geophysical model of the Moon. *Proc. Apollo 11 Lunar Sci. Conf.*, pp. 965–988.
- Wood R. W. (1912) Selective absorption of light on the Moon's surface and lunar petrography. *Astrophys. J.*, 36, 74.
- Woodcock M. R. and Pillinger C. T. (1978) Major element chemistry of agglutinate size fractions. *Proc. Lunar Planet. Sci. Conf. 9th*, pp. 2195–2214.
- Woolum D. S., Burnett D. S., and Bauman C. A. (1973) Lunar neutron probe experiment. In *Apollo 17 Preliminary Science Report*, pp. 18–1 to 18–12. NASA SP-330.
- Wright D. A. (1971) Electrical conductivity of lunar rock. *Nature*, 231, 169–170.
- Wright D. L., Olhoeft G. R., and Watts R. D. (1984) Ground-penetrating radar studies on Cape Cod. In *Surface and Borehole Geophysical Methods in Ground Water Investigations* (D. M. Nielsen, ed.), pp. 666–680. National Water Well Association, Worthington, Ohio.
- Wright R. A., Cocks F. H., Vaniman D. T., Blake R. D., and Meek T. T. (1986) Fusing of lunar materials with microwave energy; Pt. I. Studies of doping media (abstract). In *Lunar and Planetary Science XVII*, pp. 958–959. Lunar and Planetary Institute, Houston.
- Wszolek P. C., Simoneit B. R., and Burlingame A. L. (1973) Studies of magnetic fines and volatile-rich soils: Possible meteoritic and volcanic contributions to lunar carbon and light element chemistry. *Proc. Lunar Sci. Conf. 4th*, pp. 1693–1706.
- Yaniv A. and Heymann D. (1972) Atmospheric Ar⁴⁰ in lunar fines. *Proc. Lunar Sci. Conf. 3rd*, pp. 1967–1980.
- York D., Kenyon W. J., and Doyle R. J. (1972) Ar-Ar ages of Apollo 14 and 15 samples (abstract). In *Lunar Science III*, pp. 822–824. The Lunar Science Institute, Houston.
- Young J. W., Mattingly T. K., and Duke C. M. (1972) Crew observations. In *Apollo 16 Preliminary Science Report*, pp. 5–1 to 5–6. NASA SP-315.
- Young R. A. (1976) The morphological evolution of mare-highland contacts: A potential measure of relative mare surface age. *Proc. Lunar Sci. Conf. 7th*, pp. 2801–2816.
- Yuhas D. and Walker R. (1973) Long term behavior of VH cosmic rays as observed in lunar rocks. *Papers Presented to the 15th Intl. Cosmic Ray Conf.*, 2, 1116–1121.
- Zellner B., Leake M., Leberte T., Duseaux M., and Dollfus A. (1977) The asteroid albedo scale. I. Laboratory polarimetry of meteorites. *Proc. Lunar Sci. Conf. 8th*, pp. 1091–1110.

- Zinner E. (1980) On the constancy of solar particle fluxes from track, thermoluminescence and solar wind measurements in lunar rocks. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 201–226. Pergamon, New York.
- Zisk S. H. (1970) *Radar Atlas of the Moon*. Lincoln Laboratory, Lexington. 4 pp., 180 p1.
- Zisk S. H. (1972a) A new, Earth-based radar technique for the measurement of lunar topography. *The Moon*, 4, 296–306.
- Zisk S. H. (1972b) Lunar topography—first radar interferometer measurements of the Alphonsus-Ptolemaeus-Arzachel region. *Science*, 178, 977–980.
- Zisk S. H. (1978) Mare Crisium area topography: A comparison of Earth-based radar and Apollo mapping camera results. In *Mare Crisium: The View from Luna 24* (R. B. Merrill and J. J. Papike, eds.), pp. 75–80. Pergamon, New York.
- Zisk S. H., Pettengill G. H., and Catuna G. W. (1974) High-resolution radar maps of the lunar surface at 3.8-cm wavelength. *The Moon*, 10, 17–50.
- Zisk S. H., Hodges C. A., Moore H. J., Shorthill R. W., Thompson T. W., Whitaker E. A., and Wilhelms D. E. (1977) The Aristarchus-Harbinger region of the Moon: Surface geology and history from recent remote-sensing observations. *The Moon*, 17, 59–99.
- Zito R. R. (1989) A new mechanism for lunar transient phenomena. *Icarus*, 82, 419–422.
- Zonnenshtral G. A. and Pel'dman Iu. I. (1970) Specific effective scattering area of the lunar surface determined from measurements by the Luna-9 and Luna-13 automatic stations. *Cosmic. Res.*, 8, 541–546.
- Zook H. A. (1975) The state of meteoritic material on the Moon. *Proc. Lunar Sci. Conf. 6th*, pp. 1653–1672.
- Zook H. A. (1980) On lunar evidence for a possible large increase in solar flare activity 2×10^4 years ago. In *The Ancient Sun: Fossil Record in the Earth, Moon and Meteorites* (R. O. Pepin, J. A. Eddy, and R. B. Merrill, eds.), pp. 245–266. Pergamon, New York.
- Zook H. A. and Berg O. E. (1975) A source for hyperbolic cosmic dust particles. *Planet. Space Sci.*, 23, 183–203.

