SOLAR ACTIVITY, SELENOTHERMAL, AND SELENOTECTONIC EVENTS, G. H.
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The concentration gradients of the helium, neon, and argon isotopes within lunar breccias, glasses, and vesicles record the past activity of solar, selenothermal, and selenotectonic events. This is because the spatial distribution of the gases within lunar samples is the result of irradiation by external sources such as the solar wind and cosmic rays or is the result of radioactive decay from internal sources of the moon. Consequently, we can use the inert, monatomic gases as tracers for studying past processes such as solar activity or solar-wind reimplantation provided that the isotopic abundances of the gases can be measured with good spatial resolution. This is extremely important because of the remobilization and homogenization of the solar, cosmogenic, and radiogenic gases, which has resulted from the selenothermal and seleotectonic events of impact heating and brecciation.

Solar Activity

Vuggy Gabbro (15555,101) - The helium, neon, and argon isotopes from within the mafic phases and a vug from the surface of the gabbro was determined by laser-probe mass spectrometry to be derived from solar-wind implantation. The $^4He/^{20}Ne$ and $^4He/^{36}Ar$ from the vug on the rock's surface are higher than the corresponding values from the mafic phase. The $^4He/^3He$ = 2400±200 and $^4He/^{20}Ne$ = 630±60 within the vug are consistent with the solar values reported by Geiss et al (1970) from the Apollo 12 aluminum-foil solar-wind experiment. These results suggest that the past history of solar wind irradiation can be studied by isotopic measurements of the gases contained within vesicles that have been exposed to solar irradiation at different times on the lunar surface.

Breccia 14301,61 - In order to locate the excess 'parentless' ^{40}Ar content within this sample (Megrue and Steinbrunn, 1972), the distribution of stable and radioactive argon isotopes were measured by laser probe mass spectrometry after neutron irradiation of the sample in the Brookhaven high flux reactor. This new technique determines in situ the spatial distribution of $^{40}Ar/^{39}Ar$ ages on $<10^{-4}$g. of material in contrast to the more conventional $^{40}Ar/^{39}Ar$ dating method by differential heating (which measures the temporal variation of $^{40}Ar/^{39}Ar$ as released from an unknown spatial portion of the sample). Calculated $^{40}Ar/^{39}Ar$ ages of clasts within this breccia are 3.68±0.09 and 2.9±.3X10^9 years. Parentless radiogenic ^{40}Ar exists within the fine-grained matrix of the breccia and appears to have been incorporated simultaneously with solar derived argon ($^{36}/Ar/^{38}Ar \simeq 5.2$). This transient "atmosphere" of ambient gas (radiogenic ^{40}Ar/trapped $^{36}Ar \approx 14$) is most probably the result of an impact event and not the result of solar wind reimplantation.

Selenothermal Events

Glasses (15245,53) (15426,43) (15498,43,54,55) - Fractionated solar gases are found within individual glass spherules from the Apollo 12, 14, and 15 samples at a depth greater than their range of a few microns. Consequently, we must infer that these lunar glasses have been produced by

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impact melting of previously solar irradiated materials. The thermal event associated with the impact was responsible for the fractionation of the solar gases as well as the remobilization and homogenization of the gases to depths greater than their irradiation range.

Individual green and black, devitrified and nondevitrified, spherules from 15426,43 contain solar gases at a depth >5 microns and have a $^{20}Ne/^{36}Ar$ which is a factor of 2-3 higher than individual spherules from the Apollo 12 and 14 samples. The selenothermal event which produced the glass is dated at $3.8X10^9$ years (Husain, 1972) provided that we assume that no inherent radiogenic ^{40}Ar was remobilized and homogenized with the fractionated solar gases.

Glasses which occur as surface coatings on soil agglomerates (15245,53) and which occur on the surface and interior of breccia (15498,43,54,55) likewise contain fractionated solar gases at depths greater than a few microns. Consequently, the origin of these glasses is attributed to impact melting of previously solar irradiated materials and is not the result of volcanic processes.

Selenotectonic Events

Breccia (15498,37,55) and Soil Agglomerates (15245,53)- The primary gaseous constituent which occurs within the fine-grained matrices or within fissure fillings of the samples is derived from fractionated solar gases. In some cases, the fractionated gases are nearly identical with the gases which were extracted from glasses within the same sample. Consequently, the origin of the breccias is attributed to impact brecciation and agglomeration of a previously solar-irradiated regolith.

References

Geiss, J., P. Eberhardt, F. Bühler, J. Meister, and P. Signer (1970) J. Geophys. Res. 75, 5972.

Husain, L. (1972) in Apollo 15 Lunar Samples (ed. J. Chamberlain and C. Watkins) Lunar Science Institute, p. 374.

Megrue, G. H. and F. Steinbrunn (1972) Proc. of the 3rd Lunar Science Conference, M.I.T. Press, Cambridge, 1899-1916.