ORBITAL XRF OBSERVATIONS OF THE LUNAR SUBSURFACE THROUGH IMPACT CRATERS. C. G. Andre and I. Adler, Chemistry Department, University of Maryland, College Park, Md. 20742; and R. W. Wolfe, Smithsonian Institution, Washington, D. C. 20560.

A rare look at the concentration of major rock-forming elements thousands of meters below the lunar surface is provided by impact events which penetrate the surface and dredge up buried material from depth. X-ray fluorescence (XRF) measurements of Al/Si, Mg/Si and Mg/Al variations along the lunar surface have been analyzed to characterize the chemical composition at impact sites. Chemical anomalies associated with impact craters and their continuous ejecta blankets are observed in both mare and terra regions. These observations relate to the fundamental processes of chemical differentiation and mechanical redistribution of chemical components in the lunar crust.

In the maria there is evidence from XRF data that some post-mare impacts have exposed earlier basalts of a different composition from that of the surface flows. For example, variations in Mg/Al concentration in Mare Crisium indicate that the impact forming the crater Picard excavated a magnesium-rich subsurface basalt layer less than 1.8 km below the surface (1).

Those post-mare craters in the maria which exhibit unusually high Al/Si values and low Mg/Al values have most likely penetrated through mare basalt fill to basin floor material. These craters, such as Plinius, Ross, and Cauchy in Mare Tranquillitatis and Yerkes E in Mare Crisium, are the most potentially useful indicators of maximum basalt thickness determined by crater depth. Furthermore, knowledge of basalt depths constrain models of basin structure as well as volumetric calculation of mare basalt accumulation in the basins. As a corollary, those post-mare craters which do not exhibit changes in chemical composition suggest that basalts at those locations are at least as thick as the depth of the craters. This crater survey, based on XRF data, serves as an independent parameter for A) refining mare basalt isopach maps (2) based on photogeologic studies of partially flooded pre-mare craters; B) interpreting spectral reflectance measurements in terms of surface chemistry (3); and C) identifying craters appropriate for studies of the morphology of impact craters in multi-layered media (4).

Terra craters which sample subsurface compositions uncharacteristic of the surrounding terra soils indicate vertical variations in the terra crust. The evidence for lateral variation from XRF data has been previously reported (5). This subsurface material, if localized, may not be visible elsewhere on the lunar surface and may not be represented in any returned samples. Some examples of terra craters having chemical anomalies are Proclus, in the Palus Somni highlands, which has lower Al/Si and Mg/Al values than adjacent highland soils, and Capella, between Maria Fecunditatis and Nectaris, which has distinctly higher Al/Si values than the surrounding intermare area. The craters Taruntius and Langrenus also excavate terra substrata and are particularly useful for ejecta studies because they border mare areas. The aluminous ejecta from these post-mare craters spreads extensively onto the mare basalts, creating a boundary between the contrasting chemical compositions which may be traced by Mg/Al variations. Identifying ejecta boundaries which may lack physical expression is beyond the limitations of photogeology. The XRF instrument, sensitive to elemental abundances within the top tens of microns of the lunar surface, detects even the thinnest fringes of this ejecta. Thus, in these cases, the total areal extent of primary ejecta may be chemically mapped and distinguished from secondary ejecta which represents predominantly locally-derived material.

References:

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