METALLIC SI-FE-PARTICLES IN THE DEVITRIFIED GLASS SAMPLE 67629. R. Borchardt, Institut für Mineralogie, Universität Münster, 4400 Münster, W. Germany, and R. Blaschke, Institut für Medizinische Physik, Universität Münster, 4400 Münster, W. Germany.

A few metallic Si-Fe-spherules up to 40 microns in diameter (Fig. 1) have been observed in 67629 by the use of a scanning electron microscope provided with an energy dispersive x-ray system. The spherules consist of two different crystalline phases, the lighter one in Fig. 1, which seems to be an exsolution of the darker one, contains about 44 wt.% Si, 43 wt.% Fe, 8 wt.% Ni and 5 wt.% P. The darker phase is enriched in Si (60 wt.%), but depleted in Fe, P and Ni (38, 1 and 1 wt.%, respectively) compared to the lighter one. Small vugs less than a micron in size appear only in the lighter phase. The phase boundaries between the metallic particle and the neighbouring silicate phases is distinct, indicative of two unsoluble melts.

The devitrified silicate matrix of 67629 reveals spherulitic to sheath-like textures of plagioclase laths with interstitial mafic phases of olivine and/or pyroxene. These phases do not display exact stoichiometric compositions as a result of rapid cooling. Ni- bearing Fe-particles coexisting with troilite and/or schreibersite occur as larger rounded spherules in the matrix or as smaller grains interstitial between plagioclase laths.

A possible presupposition for the existence of reduced phases in a metastable state at low temperatures (e.g. schreibersite in the phosphide-phosphate-system (1)) is a rather high cooling rate of the melt, as indicated by the typical textures described above. The highly reducing conditions existing in the center of an impact, from which the melt forming the glass bombs is ejected at high velocity, might be the main reason for the development of metallic Si. Highly reducing conditions in the impact environment are also indicated in terrestrial craters by the occurrence of armalcolite (2). The formation of metallic Si is difficult to explain by volcanic processes, because of the lack of highly reducing conditions in this case.

The physical and chemical processes by which metallic Si-Fe-particles can be formed on the lunar surface are not clear. Hypervelocity impact offers the most plausible scenario for extremely reducing conditions. One possible mechanism may be the condensation of a gas phase formed by impact vaporization of lunar surface rocks and the metastable preservation of the condensed metal by rapid quenching. The formation of liquid metal droplets within a silicate impact melt, if at all possible, would need an oxygen fugacity of much less than about $10^{-18}$ atm (at this value fayalite would be only reduced to metallic iron and silica at $900^{\circ}C$ but not to silicon (3)). It appears also plausible that a highly reduced composition of the projectile favors the formation of Si-Fe-particles.

The occurrence of these particles within quenched melt ejecta ("glass bombs") and their absence from slowly cooled lunar melt rocks with subophitic, poikilitic or other crystallization textures (4) indicate that high cooling rates are obviously necessary. Further investigations are needed to elucidate the origin of these rare metallic phases.

References:
(1) Friel J.J. and Goldstein J.I. (1977) Proc. Lunar Sci. Conf. 8th, p. 3955-3965.
(2) El Goresy A. and Chao E.C.T. (1976) Earth Planet. Sci. Lett. 30, p. 200-208.
(3) Ernst W.G. (1968) Amphiboles, p. 125.
(4) Borchardt R. (1984) Ph. D. Thesis.

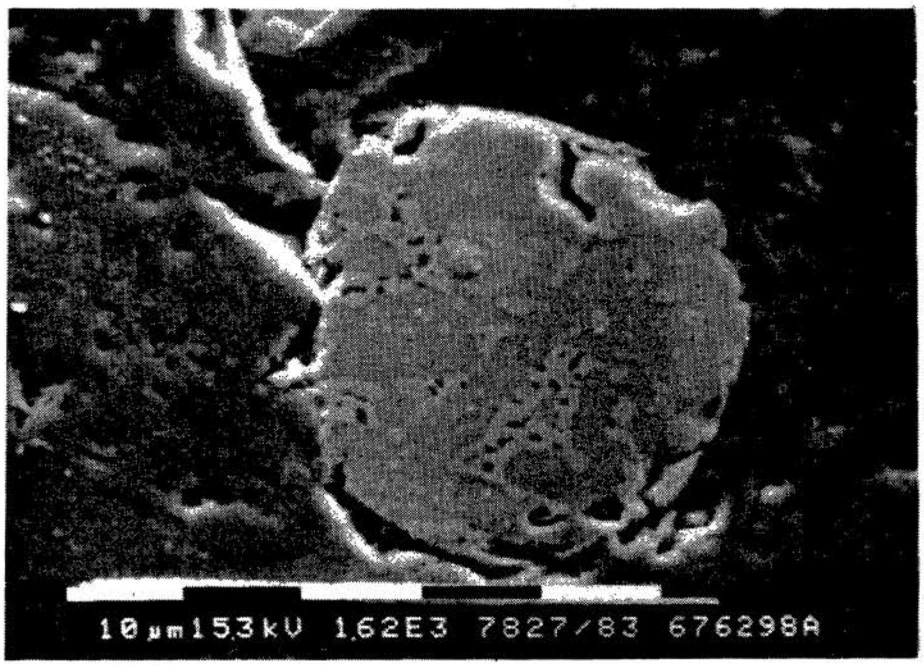


Fig. 1. SEM picture of metallic Si-Fe-particle in devitrified glass sample 67629; scale bars equal 10 microns.