NATIVE SILICON, FE-SILICIDES AND A CONDENSATE LITHOLOGY IN THE DHOFAR 280 LUNAR METEORITE. M. A. Nazarov[1], S. I. Demidova[1], Th. Ntaflos[2], and F. Brandstaetter[3] [1]Vernadsky Institute of Geochemistry and Analytical Chemistry, Moscow 119991, Kosygin St., 19, Russia, e-mail: nazarov@geokhi.ru; [2]Department für Lithosphärenforschung, Universität Wien, Althanstrasse 14, 1090 Wien, Austria, [3]Naturhistorisches Museum, Burgring 7, 1010 Wien, Austria.

Introduction: Dhofar 280 is a lunar meteorite of ferroan anorthosite composition [1-3]. Fe-silicides (Fe_2Si, FeSi, and $FeSi_2$) were identified in the rock and were interpreted as a result of the space weathering [4]. Similar Fe-silicides associated with native silicon have been found recently in Apollo 16 regolith sample 61501,22 [5]. Here we report on the occurrence of native silicon in Dho 280 and an unusual chemistry of the melt that co-exists with the highly rare minerals

Results: In the section that we studied Dho 280 is a typical impact melt breccia with an abundant anorthositic impact melt. There are rare schlieren and spot inclusions containing native silicon and Fe silicides in the impact melt (Fig. 1). The inclusions consist of aggregates of very tiny silicon grains and droplets of Fe-silicides. In bulk composition the Si^o-rich inclusions are very high in Si (up to 63 wt%). Minor elements (wt%) are: Al (0.03-3.5), Ca (0.7-2.1), Mn (0.07-0.4), Fe (2.7-11.3), Ni (up to 0.25), Mg (<0.7), and S (<0.4). Na, K, Ti and Cr are very low, if present. The inclusions show an oxygen depletion (Fig. 2) and can be considered as a mixture of silicon, Fe-silicides and a silicate melt. Raman spectra (Fig. 3) exibit however only one clear peak of silicon. A small shift of the peak from the standard position could be caused by the very fine-grained texture of the silicon aggregates [6]. Fe-silicides which are present in the Si^o-rich inclusions are FeSi and Fe_2Si (hapkeite). We found also a Fe-silicide that contains Cr and Ti and represents probably a solid solution of FeSi with some amount of $CrSi_2$ and $TiSi_2$. Common minor elements of silicides are P, Ni, Co, Cu, and P. Hapkeite is distinctly higher in these elements (up to 12 wt% Ni) as compared to other silicides containing 3.5-6 wt% Ni. There is FeNi-phosphide in some silicide droplets.

The melt adjacent to the Si^o-rich inclusions is SiO_2-rich. It shows bluish opalescence and is slightly darker in BSE (Fig. 1). Commonly the melt contains (wt%): SiO_2 55-71; Al_2O_3 17-26; FeO 0.2-1.3; MgO 1.2-4.3; CaO 6.3-15; Na_2O 0.3-1.5; K_2O up to 1.1. The mean Na/K wt. ratio is 3.6. Minor elements are Ti, Mn, Ni, and Cr. There is no any oxygen deficit in the melt (Fig. 2). Interestingly, it contains 0.2-1.4 wt% S but no sulfide inclusions are present there. Sulfur and SiO_2 contents are positively correlated. In mineral norms the SiO_2-rich melt is a mixture of plagioclase and silica with a minor mafic component (Fig. 4). The melt has variable but mostly very high MG# values (Fig. 5).

Discussion: The Si-rich aggregates contain definitely a meteorite component that is identified by enhanced Ni and Co contents in the silicides and the SiO_2-rich melt. The S enrichment of the melt could be also related to the meteorite contamination because S is lower than 0.3 wt.% in lunar rocks and resides mainly in sulfide inclusions. However Mg content of the Si-rich association is not higher than that estimated from Mg-Al relationships in lunar highland rocks. Therefore, the projectile should be of a FeNi-FeS (but not chondritic) composition (a Mundrubilla type). Therefore, the Si source should be of lunar origin but it cannot be derived by magmatic fractionation because compositions of the SiO_2-rich melts do not have any relations with cotectics (Fig. 4). Furthermore, the Si-rich association is high in Na and K and, hence, cannot be derived only from reduction of known lunar rocks. KREEP, granites and monzodiorites are highest in Si, Na and K among lunar rocks but as compared to the Dho 280 Si-rich association derivates reduced from KREEP should be higher in Mg whereas reduced products of granites and monzodiorites would be much higher in K/Na. Reduction of Si^o from anorthosites would lead to a Ca and Al enrichment of the SiO_2-rich melts. One fragment of a Ca, Al-rich (HASP) glass [e.g.,7] was indeed found in Dho 280, but not in a close association with the Si^o-rich objects. Therefore, the source of the Si-rich association should not be related also with the Dho 280 host rock by reduction processes. The enrichment in Si, Na, K and Fe is the feature of condensates formed from silicate impact- induced vapor. Such condensate spherical particles and clasts have been found in lunar soils [7,8]. Some of the condensates are very high in SiO_2 whereas others are Fe-rich. Mostly the condensates are rich in K/Na but there are some spheroids (GM, GN, HB [7]) which are very close in composition to the SiO_2-rich melt of Dho 280. Thus it can be suggested that the Si-rich association of Dho 280 was formed by condensation of an impact-induced vapor, remelted and mixed with the Dho 280 host rock. The volatile element enrichment [9] and the meteorite contamination of the Si-rich association support this scenario. The reduction could have taken place in the vapor as well as in the Dho 280 impact melt and could be caused by simple thermal decomposition in the vapor or by a reducing agent, e.g., CO. We can suggest that such reduction and condensation processes could affect major and minor element chemistry of lunar impact deposits.

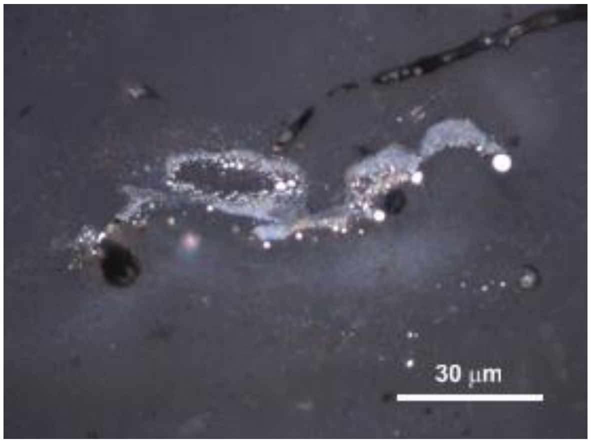

Fig. 1. A Si-rich object. Silicon is bluish-gray. Bright droplets are Fe-silicides. The SiO_2-rich melt shows bluish opalescence. Reflected light.

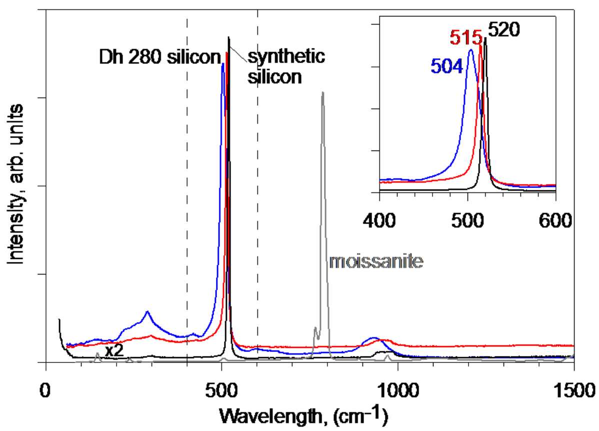

Fig. 3. Raman spectra of Si°-rich inclusions. There is a shift of measured peaks relative to the synthetic silicon peak.

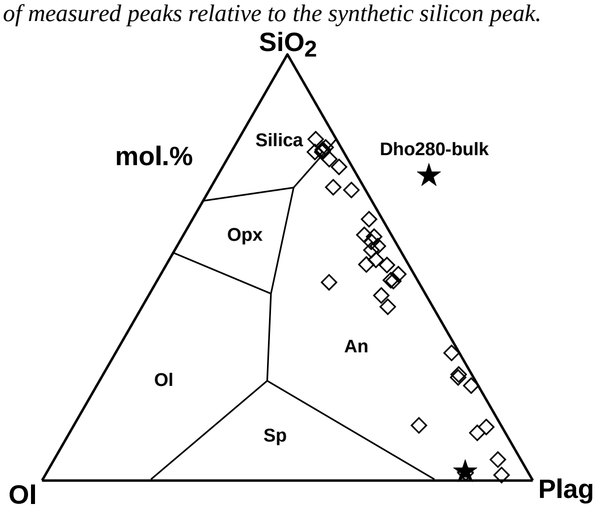

Fig. 4. Mineral norms of the SiO_2 –rich melts.

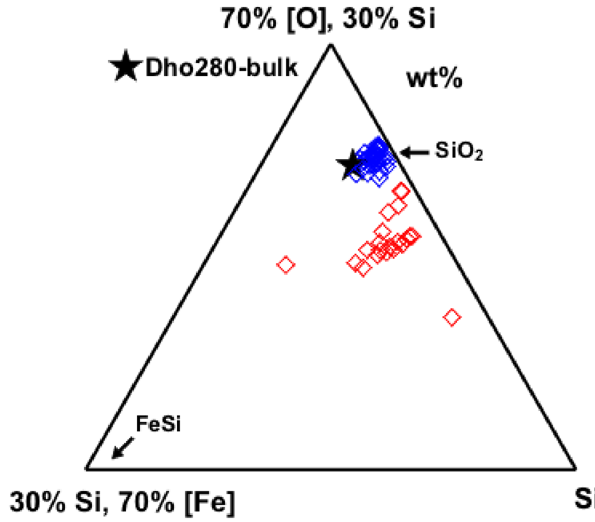

Fig. 2. [Fe]=Fe+Ni+Mn+Cr+Ti+S (wt%). [O]=100-CaO-Al_2O_3-Na_2O-K_2O-Si-[Fe](wt%). The red diamonds are Si°-rich inclusions, blue ones are SiO_2-rich melts.

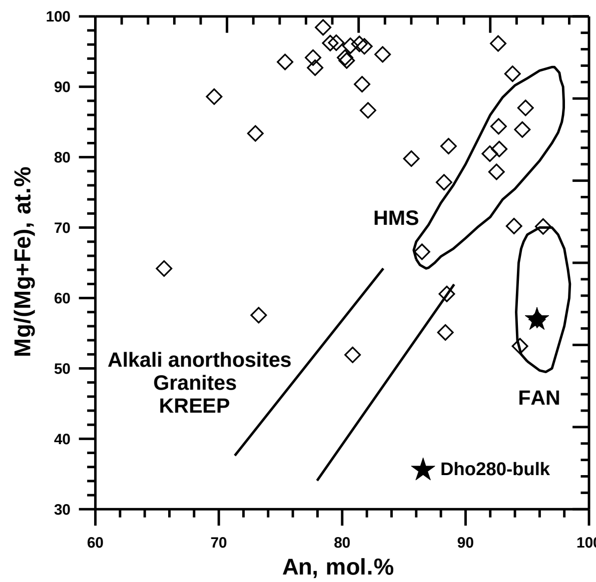

Fig. 5. MG# vs. An of the SiO_2 –rich melts.

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