SILICA-BEARING OBJECTS IN THE DENGLI H3.8 AND GORLOVKA H3-4 CHONDRITES

Ivanova M.A.[1], Kononkova N.N.[1], Petaev M.I. [1,2] 1 - Vernadsky Inst. Geochem. Analyt. Chem. RAN, Moscow, Russia; 2 - Harvard-Smithsonian Center for Astrophysics, Cambridge, MA, USA

Silica-bearing objects are enigmatic components of the olivine-normative ordinary chondrites. Several papers [1,2 and references therein] has been devoted to the study of these objects in various chondrite types. While a relatively large body of information has been collected, the origin of these objects is still controversial. Here we report new data on silica-bearing objects in the unequilibrated H-chondrites Dengli and Gorlovka. The crystallization history of these objects could be explained on the basis of the phase diagram of the Q-Ol-Pl (Al_2O_3) system, but the origin of the silica-rich liquids remains unclear.

STRUCTURE AND MINERALOGY. The clast in (Fig. 1a), from the Dengli H3.8 chondrite [3] is irregular in shape and ~ 160 µm in size. It has a granular mosaic structure and consists of relatively large grains of a silica (65 vol.%) and low-Ca pyroxene (25 %), with interstitial sub-calcic augite (1.6 %) and bitownite (3 %). Terrestrial oxides filling cracks in the clast make up 6.1 % of it. Because of its fluorescence, the silica mineral has been identified as crystobalite. This clast appears to be the most silica-rich of all such objects studied so far.

Silica-bearing objects in the Gorlovka H3-4 chondrite include clasts and chondrules. Major phases in these objects are low-Ca clinopyroxene and Si,Al-rich glass, often saturated with tiny skeletal crystals of high-Ca pyroxene. Many other chondrules and clasts lacking a silica mineral have such a glass as a principal constituent.

One of the silica-bearing objects in Gorlovka (Fig. 1b), #M-1, an ellipsoidal clast ~ 1.8x1.1 mm, has microporphyritic structure and consists of zoned euhedral and subhedral pyroxene grains and small amount of mesostasis. The central part of the clast contains anhedral silica grain of about 50 µm dimension. The boundaries between pyroxene and mesostasis or silica are decorated by high-Ca pyroxene rims of varying thickness. The clast contains rare veinlet-like or rounded grains of metal and troilite.

Another clast, #B2-1, almost rectangular with rounded corners (Fig. 1c), ~ 0.8x0.3 mm in size, also has microporphyritic structure and consists of the same phases, but in roughly 1:1 ratio. The clast contains two clusters of euhedral silica laths up to 250 µm in length. The mesostasis of the clast is saturated with tiny skeletal crystals of high-Ca pyroxene and separated from the other phases by µm-thick rim of high-Ca pyroxene. Rare thin veins of the same composition cross the silica laths.

The third clast, #B1-2 (Fig. 1d), is ~ 260x100 µm rectangular granoblastic aggregate consisting mainly of blocky grains of silica mineral separated by low-Ca pyroxene with subordinate olivine in vein-like geometry.

The fourth object, #B1-3, an ~ 0.8x0.6 mm ellipsoidal complex chondrule (Fig. 1e), contains a continuous concentric internal layer of silica mineral varying in thickness from ~ 10 to ~ 30 µm. The major phases, again, are subhedral grains of low-Ca pyroxene and mesostasis in roughly 5:1 ratio. Pyroxene in the interior of the chondrule occurs as subparallel laths, and in its outer part as equidimensional grains. The domains with differently oriented pyroxene grains are separated by the layer of silica mineral. The low-Ca pyroxene grains are decorated by thin rims of high-Ca pyroxene along boundaries with other phases.

MINERAL CHEMISTRY. Mineral compositions in the Dengli clast shows only minor variability; mean values are listed in Table 1. Also in Table 1 is the mean composition of Gorlovka's siliceous mesostasis. The glass can be characterized by the approximate formula (Mg,Fe,Mn,Ca,Na,K,Ti,Cr,Al)[$Al_2Si_7O_{18}$] with minor deviations from this "stoichiometry". The compositions of pyroxenes, especially high-Ca Px, vary considerably within and between objects (Fig. 2). In glass-bearing objects, orthopyroxene also shows intragrain variations; an example is shown in Fig. 3. In clast #B1-2 orthopyroxene is more ferrous and even more variable in composition than in other objects and in the meteorite as a whole, and it coexists with rare grains of ferroan olivine (Fa_{25-32}).

DISCUSSION. All of the objects studied, except #B1-2, have clear igneous textures, and their origin can be explained by the crystallization of silica-rich melts in the system Q-Ol-Pl (Al_2O_3) [1,2]. The bulk compositions of all the objects plot inside silica crystallization field: silica is the first liquidus phase, followed by low-Ca pyroxene. The crystallization sequence thereafter depends upon the primary composition and cooling history. In the Dengli clast slow crystallization of residual liquid formed high-Ca pyroxene and bitownitic plagioclase in interstices between the major minerals (silica and low-Ca pyroxene). The Gorlovka objects experienced fast cooling, and residual liquids were quenched to glassy mesostases. The precipitation of tiny skeletal grains of high-Ca pyroxene from these mesostases appears to have occurred later, probably during a shock reheating event on the parent body.

The most difficult question is, how were liquids so rich in silica produced in the first place? Several mechanisms have been proposed [1,2], but none of them seem to be totally satisfactory. In principle, alumina- and silica-rich and alkali-poor melt could be produced by the partial melting of H-chondrite precursor, followed by the

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System

SILICA-BEARING OBJECTS: Ivanova M.A. et al.

removal of alkalies, for instance by volatilization. The observed enrichment of glassy mesostases in K relative to Na seems to support such a suggestion. However, details of the composition and texture of silica-bearing objects, especially in Gorlovka, are inconsistent with such a simple story. A multistage crystallization history seems to be needed to explain the origin of the internal silica-mineral layer in Gorlovka chondrule.

REFERENCES: [1] Brigham C.A. et al.(1986) *GCA*, **50**, 1655-1666 [2] Ruzicka A., Boynton W.V. (1992) *Meteoritics*, **27**, 284 [3] Ivanova M.A. et al. (1992), *Meteoritics*, **27**, 463-464

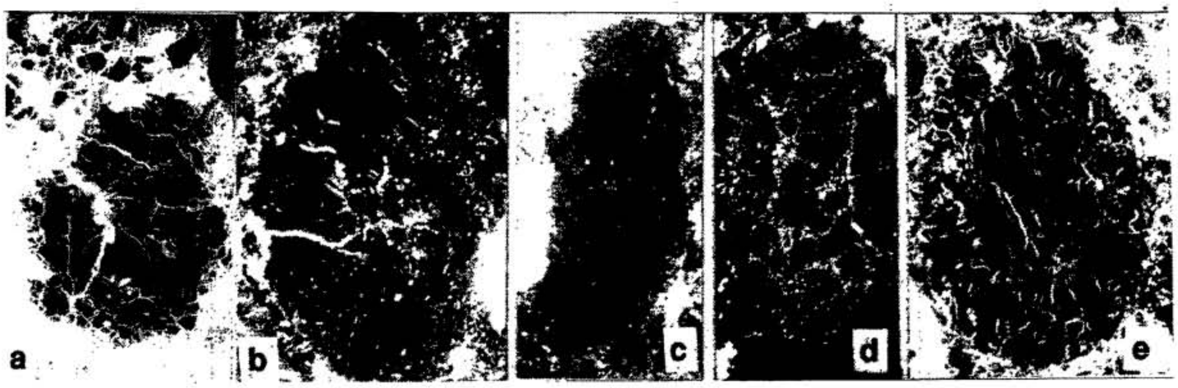

Fig. 1. BSE images of silica-bearing clasts. Silica (black), pyroxenes (light-grey), plagioclase or glass (medium grey). A - Dengli(~160 μm); b - e - Gorlovka; b - #M-1(~1.8x1.1 mm), c - #B2-1(~0.8x0.3 mm), d - #B1-2(~0.26x0.1 mm), e - #B1-3(0.8x0.6 mm).

Table 1. Mineral chemistry

		Dengli		Gorlovka
	Opx	Cpx	Pl	Glass
SiO2	56.38	52.80	49.45	72.77
TiO2	0.09	0.74	0.10	0.38
Al2O3	1.09	4.35	33.48	17.99
Cr2O3	1.02	1.67	n.d.	0.29
FeO	11.17	10.09	0.34	1.39
MnO	0.40	0.45	0.35	0.04
MgO	27.33	18.53	n.d.	2.60
CaO	3.08	12.96	15.39	1.56
Na2O	0.18	0.27	2.59	0.78
K2O	<0.05	<0.05	<0.05	0.69
Total	100.69	101.91	101.75	98.49

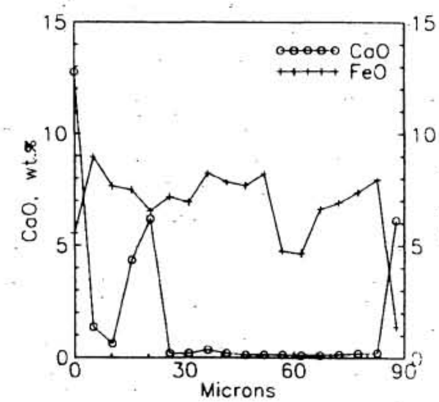

Fig. 3. Intragrain variations in Gorlovka Px.

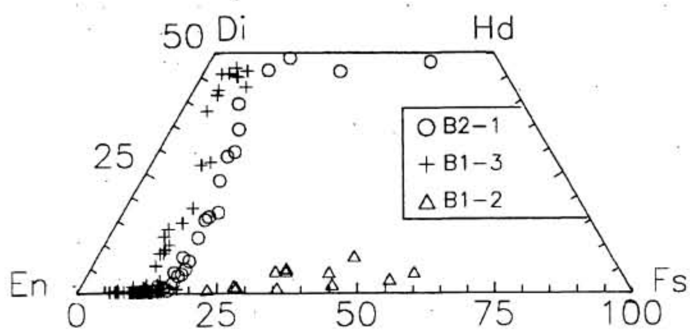

Fig. 2. Intergrain variations in Gorlovka Px.

© Lunar and Planetary Institute • Provided by the NASA Astrophysics Data System