

## DIFFERENTIATED PRECURSOR FOR SILICATE INCLUSIONS IN THE ELGA IRON METEORITE.

S. N. Teplyakova<sup>1</sup>, Yu. A. Kostitsyn<sup>1</sup>, and N. N. Kononkova<sup>1</sup> Vernadsky Institute of Geochemistry and Analytical Chemistry, Russian Academy of Sciences ([syun2002@mail.ru](mailto:syun2002@mail.ru))

**Introduction:** Silicate inclusions (SIs) in IIE irons vary in composition from chondritic to highly fractionated silica-, alkali-rich ones. It has been suggested that the inclusions could be probably formed by partial melting of a H-chondrite precursor, or by condensation from the solar nebula gas [1-5]. Here we report on mineralogy and major and trace element chemistry of SIs from the Elga (IIE) iron meteorite.

**Methods:** Mineral phases in 17 SIs were analysed with SX-100 electron microprobe. Bulk composition of the SIs was computed on the basis of the mineral chemistry and mineral modes. Trace elements were measured in 4 SIs by LA-ICP-MS (40  $\mu\text{m}$  spots). One inclusion was analysed by INAA.

**Results:** The Elga SIs, up to 4 mm in size, consist of euhedral and skeletal pyroxene crystals, 40-500  $\mu\text{m}$  in size, ( $\text{Wo}_{34-44}\text{En}_{44-50}$ ;  $\text{Cr}_2\text{O}_3$  1.5 wt%;  $\text{Fe}/\text{Mn}=13-47$ ). Some pyroxenes contain bronzite exsolution lamellae of 1  $\mu\text{m}$  thick oriented parallel to the (100) plane. The pyroxene crystals are embedded in a  $\text{SiO}_2$ -rich feldspathic glass ( $\text{Ab}_{72-92}\text{Or}_{7-26}$  to  $\text{Ab}_{38-43}\text{Or}_{53}$ ). Minor phases are bronzite ( $\text{Wo}_{1-3}\text{En}_{72-79}$ ;  $\text{Fe}/\text{Mn}=20-32$ ), chromite ( $\text{TiO}_2$  5.5 wt%  $\text{Al}_2\text{O}_3$  2.3 wt%), whitlockite, F-apatite, taenite, kamacite, troilite, pentlandite and swathing schreibersite. Mineral modes (vol.%) are pyroxene 22-34; glass 66-78. Some inclusions consist of  $\text{SiO}_2$ -rich feldspathic ( $\text{Ab}_{30}\text{Or}_{70}$ ) glass only. The bulk composition of representative SIs is given in Table 1.

Table 1.

	1	4A	6B	sl 2a	6C	6E	3.3 D
$\text{SiO}_2$	66,20	68,08	68,86	65,96	71,25	78,55	69,85
$\text{TiO}_2$	0,45	0,16	0,13	0,69	0,57	0,67	0,55
$\text{Al}_2\text{O}_3$	14,16	11,55	12,79	12,07	13,10	16,29	12,73
$\text{Cr}_2\text{O}_3$	0,28	0,42	0,32	0,31	0,29	0,01	0,39
$\text{FeO}$	2,80	2,40	2,36	2,12	2,35	0,32	2,07
$\text{MnO}$	0,08	0,10	0,08	0,10	0,10	0,01	0,10
$\text{MgO}$	3,54	5,18	0,08	4,50	4,19	0,04	4,99
$\text{CaO}$	3,95	5,63	4,51	4,50	4,10	0,02	5,60
$\text{Na}_2\text{O}$	6,69	2,20	5,37	3,55	2,65	0,96	1,77
$\text{K}_2\text{O}$	1,84	4,23	1,82	5,11	1,40	3,14	1,88
Total	100,0	100,0	100,0	100,0	100,0	100,0	100,0

Based on REE patterns and bulk chemistry, glasses were subdivided into G1 and G2 types. G1 glasses occur mostly in augite-bearing SIs, and G2s - in glassy inclusions. Augites and glasses demonstrate a negative Eu anomaly (Fig. 1.). Augites are enriched in HREEs over LREEs and have distinctly high Sc and Y contents. The G1 glasses vary in REE from 0,2xCI to

12 x CI and show flat patterns. They have high contents of Rb and Nb (1-25 x CI) and are strongly depleted in Cr (0,0002 x CI). Their Sc, Ti, Mn, Hf, Th, Zr, Nb, Rb, Sr and Ba concentrations are complementary to those of pyroxenes. The G2 glasses are more homogeneous than G1 glasses and also show a flat REE pattern (2-8 x CI). The G2 glasses are extremely enriched in Rb (400 x CI) and have high contents of Nb (25 x CI) and Zr (10 x CI). Bulk trace element contents measured by INAA in an augite-bearing SI show a prominent negative Eu anomaly and enrichment in LREEs (25-260 x CI) over HREEs (blue lines Fig. 1.).

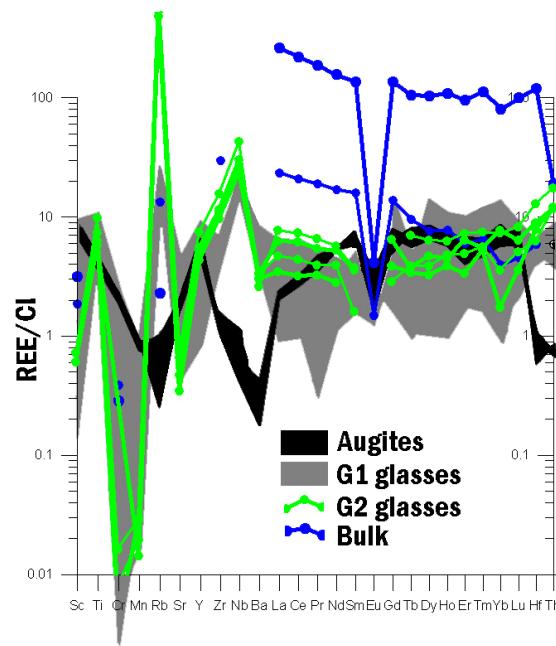


Fig. 1. Trace and REE contents in SIs of the Elga meteorite

**Discussion:** The bulk compositions of the Elga SIs are enriched in Si, K, Na, and Rb, Nb in comparison with H chondrites. The REE patterns show the prominent negative Eu anomaly and suggest that Ca-plagioclase could be lost during the precursor formation. The bulk REE contents are higher than those in augites and glasses and indicate that the REE excess could be related to a presence of phosphate. We have compared the mineral/melt partitions coefficients (p.c.) of the SIs of Elga with SIs of the Kodaikanal IIE meteorite [5] and differentiated rocks such as achondrite

and terrestrial rhyolites, Rattlesnake Tuff and Bishop Tuff [7-9]. The augites/glass p.c. of the Kodaikanal's SIs (blue line in Fig.2.) are similar to those of the Elga's SIs, and suggest that these SIs could be formed like the Elga's SIs. The achondrites p.c. were determined based on experimental work [6]. They are shown in red spots in the plot (Fig.2) and different from those of the SIs. Terrestrial rhyolites which have similar compositions, mineralogy and REE contents with those of the SIs are shown in yellow area in the plot (Fig.2), and they are in the range of values for the SIs.

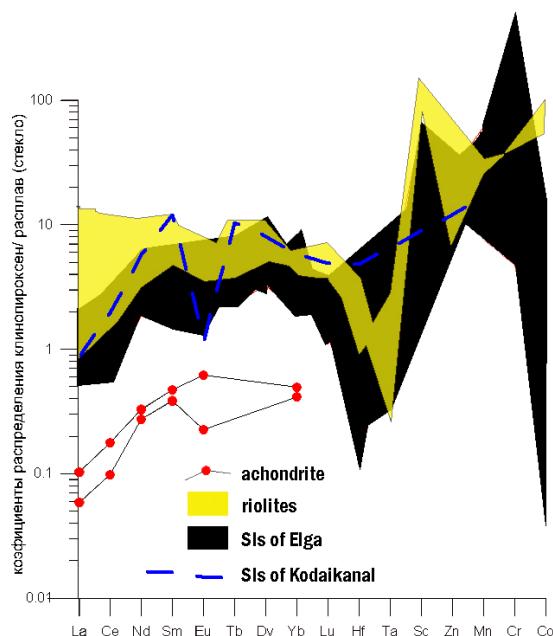


Fig.2 Partitions coefficients of augites/melt for rhyolites, acondrite and SIs of IIE

The SIs of Elga are similar to those of rhyolite in compositions in terms of petrography, mineralogy, REE abundance and the p.c. of phenocryst/matrix. However, pyroxens composition (MG# 50) of rhyolite is different from that of the Elga SIs (MG#=71-84). We propose that the SIs of Elga could be formed during intensive differentiation process, and intensity of the prosess was comparable with differentiation process of the Earth that lead to formation of the terrestrial igneous rocks. Then, during a following impact event, differentiated rocks were mixed with the Elga IIE metal.

**References:** [1] Ikeda Y. et al. (1997) *Antarctic Meteorite Research*, 10, 355-372. [2] Olsen E. et al. (1994) *Meteoritics*, 29, 200-213. [3] Ruzicka A. et al. (1999) *GCA*, 63, 2123-2143. [4] McCoy T.J. (1995) *Meteoritics*, 30, 542-543. [5] Kurat G. et al. (2007)

*MAPS*, 42, 1441-1463. [6] McKay G. et al. (1994) *GCA*, 58, 2911-2919. [7] Mahood G.A. et al. (1983) *GCA*, 47, 11-30. [8] Michael P.J. (1988) *GCA*, 52: 275-282. [9] Streck M.J. (1997) *Journal of Petrology*, 38 (1), 133-163.