TRACE ELEMENTS IN SILICATE MINERALS FROM PORPHYRITIC AND NONPORPHYRITIC CHONDRLES OF EOC

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Introduction: Ordinary chondrites are the most abundant meteorite type on Earth and construct of silicate spherules – chondrules. Chondrules characterizes very restrained mineralogical composition (olivine, low-Ca pyroxene, and mesostasis), but has a wide range of textures [1]. Trace element composition analysis by SIMS method allow determine geochemical differences of chondrules minerals and reveal diversity of formation conditions for varios textural types of chondrules. This research is concentrated on trace element composition analysis of silicate minerals from pophyritic, barred, radial, and granular chondrules in Kargapole (H4), Orlovka (H5), Saratov (L4), Elenovka (L5), Buschhof (L6), Bjurböle (L/LL4), and Knyahinya (L/LL5) meteorites, provided by private collectors and Mining museum of St. Peterburg Mining university.

EOC material experienced influence of thermal metamorphism on chondritic parent bodyis, what led to equilibration of major elements in olivine and low-Ca pyroxene and recristallization of chondrule mesostasis to plagioclase. Nevertheless, as previos studies showed [2, 3], trace elements concentrations in olivine and pyxene remin on the same level as UOC minerals and demonstrate no signs of equilibration.

Major elements content was detected by SEM-EDS method on a scanning JEOL JSM-6510 LA electron microscope in IPGG RAS. Content of trace elements in olivine was determined by the method of mass spectrometry of secondary ions (SIMS) on a Cameca IMS-4f ion microprobe in VALIEV IPT RAS using the procedure described in [4] .

Results: The distribution of trace elements in olivine, low-Ca pyroxene, and plagioclase of porphyritic and non-porphyritic chondrules of equilibrated ordinary chondrites reflects the heterogeneity of the conditions of chondrule-forming processes in the protoplanetary disk and identify their evolution. Porphyritic chondrules (P) are composed of olivine with a low content of Y and Yb relative to non-porphyritic chondrules. The enrichment of low-Ca pyroxene P chondrules with trace elements correlates with the amount of pyroxene in the chondrule. Olivine composition in granular chondrules is close to olivine P chondrules, but low-Ca pyroxene is distinguished by a high content of Y, Ti, Sr, Ba, V, and REE compared to all other chondrules. The barred chondrules are characterized by olivine with trace element high content (Zr, Y, Ti, Ba, Cr, HREE) and low-Ca pyroxene highly depleted in trace elements (Zr, Y, Nb). The pyroxene of radial chondrules is enriched in Nb, Sr, and Ba.

Trace elements in olivine and low-Ca pyroxene indicate the formation of porphyritic and granular chondrules in a stable region of the protoplanetary disk, which is responsible for low melt heating temperatures and slow cooling of the chondrule. Trace element enrichment of olivine from barred chondrules reflects strong heating of the precursor material and rapid cooling of the chondrule melt. Mineral composition of radial chondrules demonstrate rapid cooling of a low-temperature melt depleted in Mg and trace elements. High melt temperatures of barred chondrules and rapid cooling of nonporphyritic chondrules indicate their formation in an unstable region of the protoplanetary disk. Trace element in silicate minerals of porphyritic and non-porphyritic chondrules reflect their formation as a result of the melting of mineral precursors.

References: [1] Chondrules: Records of Protoplanetary Disk Processes / Ed. S.S. Russell et all. Cambridge University Press, 2018. 450 pp. [2] Sukhanova K. et al. 2020. International Geochemistry 65: 1176-1185. [3] Sukhanova K. et al. 2022. Doklady Earth Sciences 504: 28-33. [4] Sobolev, A.T., Batanova, V.G. (1995). Petrology, 3(5), 440-448.