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**GEOCHEMISTRY OF REE IN HARZBURGITES FROM CONTINENTAL
ULTRAMAFIC AND MAFIC-ULTRAMAFIC MASSIFS**

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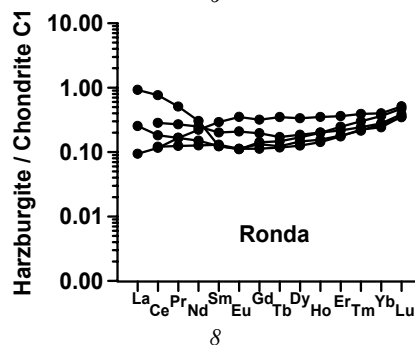
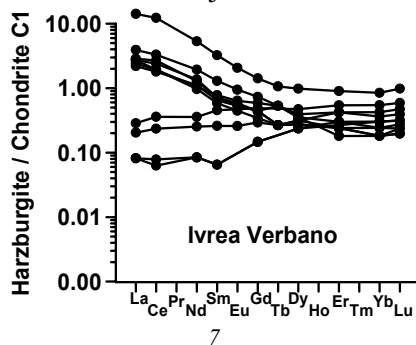
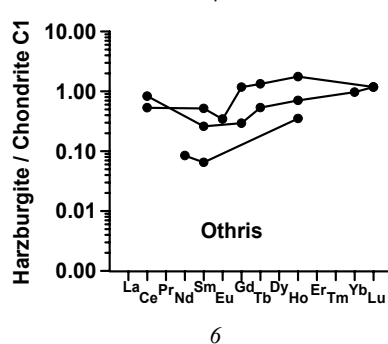
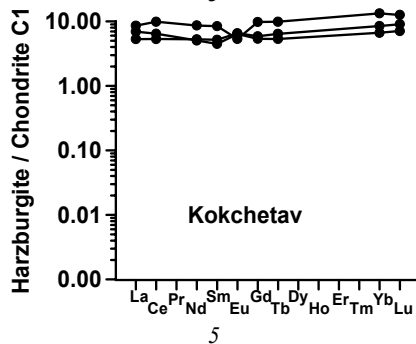
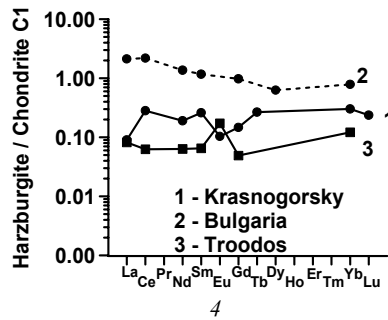
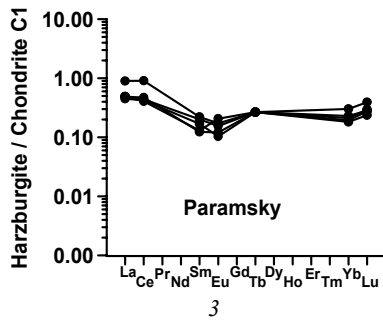
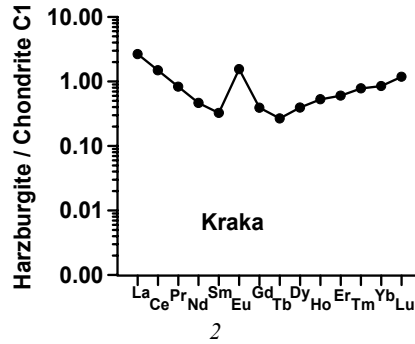
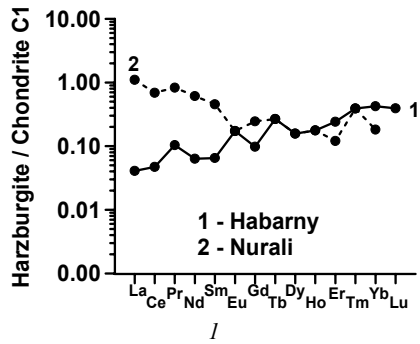
Harzburgites, similar to lherzolites and dunites, from continental mafite-ultramafite associations are normally considered as mantle restites that are substantially REE depleted. The data on their concentrations in the above rocks at present are quite limited. This paper for the first time generalises the results of more than 100 published REE analyses for harzburgites from various massifs, considers the possibility of contamination of harzburgites and other restites by light REE under the influence of later fluids.

Key words: harzburgites, REE, geochemistry.

According to the existing conceptions, harzburgites, as well as lherzolites and dunites, contained in continental ultramafite massifs from ophiolite associations, are refractory residual products (restites) that had formed under the high melting degrees of the mantle source. In the author's opinion, the same ultramafites are very often present in compound of mafite-ultramafite massifs that are studied either in terms of the model of intra-chamber differentiation of picritic melts, or the model of polygenic mafite-ultramafite plutons formed by the mantle restite protrusions, and gabbroid intrusives that break through and transform them [6].

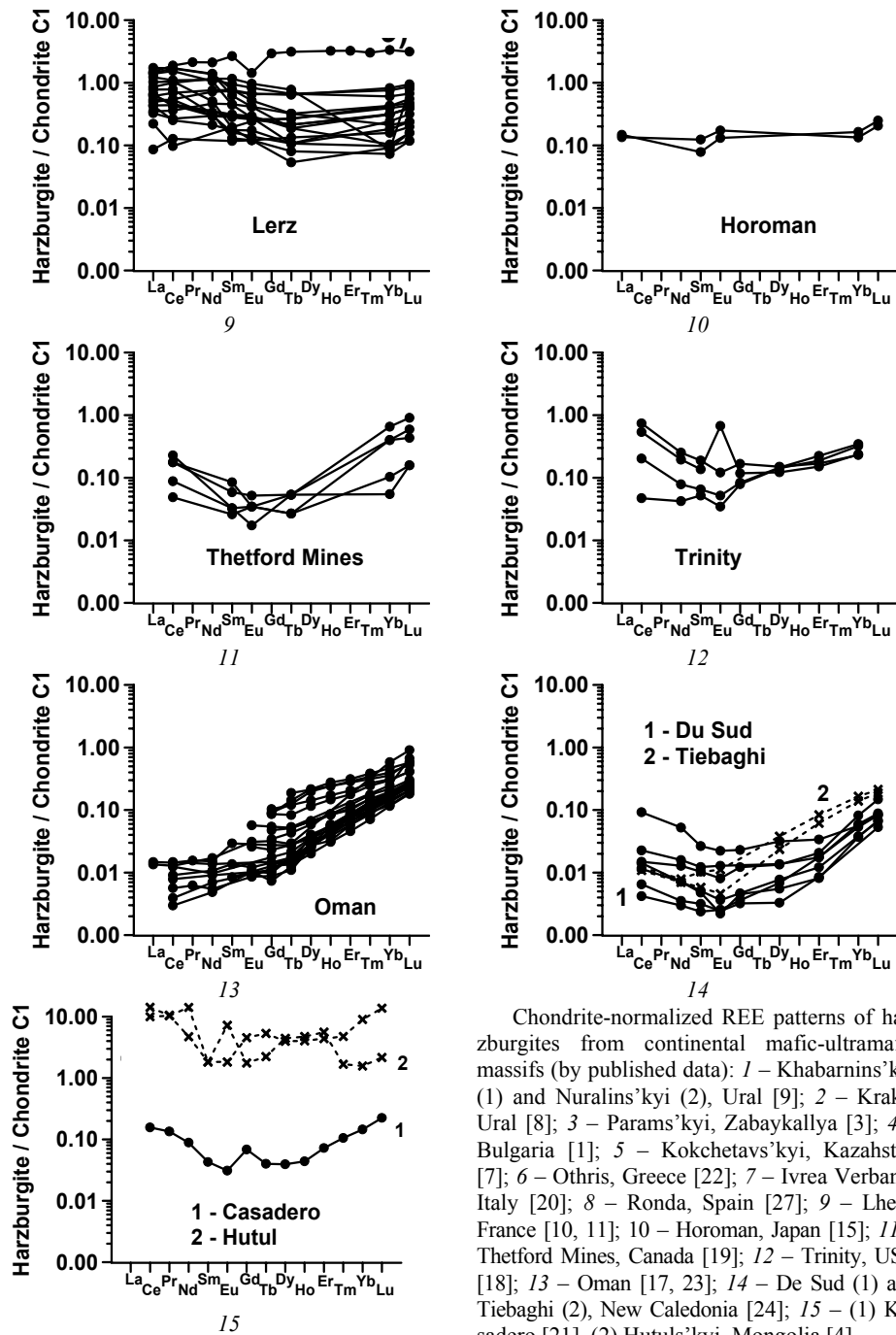
Various approaches are used in petrological studies of ultramafite restites including the study of geochemistry of incompatible elements. An important portions of the latter are the REE. Due to the strong depletion of such rocks of REE the data on REE distribution in harzburgites and other restites from continental massifs are quite limited. Yu. Balashov [2] was one of the first scholars to provide the results of several REE analyses for harzburgites from mid-oceanic ridges. Later, the graphical data on REE content in harzburgite samples from the Josephine continental massif were published [13]. However, in the recent 20 years more than 100 analyses have been made of harzburgites from many continental ultramafite and mafite-ultramafite massifs.

The total REE content in harzburgites is within the interval from 0.01 (Sud and Tiebagi massifs) to 23 ppm (Kokchetavskiy); on the average it is 1.7 ppm and this is close to their content in chondrite. Of the REE in harzburgites, Ce and Nd prevail by absolute content. In the analyses sampling that we studied, the minimum and maximum contents of individual elements differ by the factor of 2 to 4. REE fractioning degree, i.e., the value of $(La/Yb)_n$ parameter, varies from 0.03 to 17; this is, in the first place, caused by the fluctuations of the La content; at the same time, Yb content is much more stable. In such massifs as Lherz, Rhonda, Horoman, Kokchetavskiy, the $(La/Yb)_n$ value is close to 1; consequently, distribution spectra of chondrite-normalized REE contents have sub-horizontal position (Fig.).



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Chondrite-normalized REE patterns of harzburgites from continental mafic-ultramafic massifs (by published data): 1 – Khabamins’kyi (1) and Nuralins’kyi (2), Ural [9]; 2 – Kraka, Ural [8]; 3 – Params’kyi, Zabaykallya [3]; 4 – Bulgaria [1]; 5 – Kokchetavs’kyi, Kazahstan [7]; 6 – Othris, Greece [22]; 7 – Ivrea Verbano, Italy [20]; 8 – Ronda, Spain [27]; 9 – Lherz, France [10, 11]; 10 – Horoman, Japan [15]; 11 – Thetford Mines, Canada [19]; 12 – Trinity, USA [18]; 13 – Oman [17, 23]; 14 – De Sud (1) and Tiebaghi (2), New Caledonia [24]; 15 – (1) Kasadero [21], (2) Hutuls’kyi, Mongolia [4].

Harzburgites from the massifs of Oman are rapidly depleted of light REE and have very low values of $(La/Yb)_n$, their spectra have a steep positive slope. In the Ivrea Verbanò massif some samples have sub-horizontal spectra, other samples have negatively inclined spectra due to the fact that they are rich in light REE. In this case, concentration of light REE has bi-modal distribution. In many massifs all the harzburgite samples studied appear to be enriched by light REE. Their spectra have U-shape and demonstrate a subdued minimum in the domain of middle elements. On the background of such minimum sometimes positive or negative Eu anomalies are observed. The vivid examples of such enrichment by light REE and U-shape of REE distribution spectra are the harzburgites from such massifs as Kraka, Params'kyi, Tetford Mines, Sud and Tiebagi, and some individual samples from Ivrea Verbanò, Ronda, Lerz and Khabarnins'kyi.

The considered abnormal enrichment of restite ultramafites by light REE does not have any unequivocal explanation so far. In the opinion of some scholars, relative depletion of such rocks of medium REE is stipulated for the conditions of the partial melting process of the mantle source [24]. According to later studies, such enrichment of harzburgites, as well as other restites, by light lanthanoids has an epigenetic character and can be explained by the processes of influence on restites by the later low-temperature fluids under the earth's crust conditions [18]. At that, it is supposed that an essential portion of light REE identified in bulk rock samples, is localised not in the structure of rock-forming minerals, but is concentrated in the form of contaminate in the inter-grain space, at the walls of micro-fractures and in the fluid inclusions. The author of this paper shares the opinion on such interpretation, as well.

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**ГЕОХІМІЯ РІДКІСНОЗЕМЕЛЬНИХ ЕЛЕМЕНТІВ У ГАРЦБУРГІТАХ
ІЗ КОНТИНЕНТАЛЬНИХ УЛЬТРАМАФІТОВИХ І
МАФІТ-УЛЬТРАМАФІТОВИХ МАСИВІВ**

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Гарцбургіти, як лерцоліти і дуніти, із мафіт-ультрамафітових асоціацій континентів прийнято трактувати як мантійні рєстити, суттєво збіднені рідкісноземельними елементами. Дані про їхні концентрації в цих породах поки є в обмеженій кількості. Вперше узагальнено результати понад 100 опублікованих аналізів гарцбургітів на РЗЕ із різних масивів, розглянуто імовірність контамінації гарцбургітів та інших рєститів легкими РЗЕ під впливом більш пізніх флюїдів.

Ключові слова: гарцбургіти, рідкісноземельні елементи, геохімія.

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