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Trace element and age characteristics of zircons in lower crustal xenoliths from the Grib kimberlite pipe, Arkhangelsk province, Russia

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The suite of 14 xenoliths comprises garnet granulites and metamorphic garnet clinopyroxenites equilibrated under 670-780 oC, 0.8-1.2 GPa. The rocks are medium- to coarse-grained, foliated or banded, with granoblastic or porphyroblastic texture. Grt-clinopyroxenites are similar in mineral composition to granulites.
U–Pb dating of zircons separated from xenoliths was carried out on a SHRIMP II ion microprobe at the Centre of Isotopic Studies of the Karpinsky All-Russia Research Institute. The REE and trace element compositions of zircon and rock-forming minerals have been obtained using LA-ICP-MS facilities at Birkbeck/UCL. The bulk rock compositions have been reconstructed because of the high degree of alteration of the xenoliths.
Zircons exhibit complex zoning in CL. In all samples including garnet clinopyroxenites, dark cores and bright homogeneous rims are present. In two samples, homogeneous domains are surrounded by darker convoluted overgrowths. Late generation zircons were in equilibrium with garnet as follows from their low Y and HREE contents except for one granulite xenolith. For this sample we suggest that convoluted zircon grew before garnet. Homogeneous zircon was formed by recrystallization of older zircon generations and convoluted zircon formed by subsolidus growth. Most zircons of late generations, both homogeneous and convoluted, show concordant ages in the range of 1.81-1.84 Ga (1826±11 Ma) which we interpret as the age of last granulite-facies metamorphism. Exceptions are a few younger discordant zircons. Many zircon grain cores were reset at this time.
Zircon grain cores exhibit different textures: sector, oscillatory, but often disturbed. In one sample, cores of different texture and composition have the same age of 1.96 Ga. Some of the cores have steep positive slope of HREE, the others are significantly richer in U and show flat REE patterns. We suggest that U-rich zircon is metamorphic, formed by subsolidus growth, and the others are inherited and reset during this metamorphic event. The protolith of this granulite was probably a sedimentary rock. In another sample, the cores display oscillatory zoning and many of them include sector zoned inner domains. These zircon generations are different in trace element concentrations although both are characterized by steep positive slope of HREE, high Y content and high Th/U. Most cores have been completely reset at 1.81 Ga, some of them are discordant, but three of them yield concordant age of 2719±14 Ma. The oscillatory zircon probably crystallized in magmatic protolith of this granulite while the sector zoned zircon is inherited. This sample corresponds in composition to a diorite.
The obtained age values correspond to major metamorphic events recorded in crustal rocks of the north-eastern Baltic shield: collisional metamorphism and magmatism in Belomorian mobile belt 2.7 Ga ago and reworking of Archaean rocks during Svecofennian orogeny. The lower crust beneath the Grib kimberlite pipe consists of metasedimentary granulites and metaigneous granulites and pyroxenites at least some of which are Archaean.