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Trace element and oxygen isotope compositions of grossular-rich magmatic garnets from the lower crustal Galiléia granitoids, Araçuaí orogen, SE Brazil

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In the Araçuaí orogen, in the central domain of its crystalline core, the Neoproterozoic (ca. 630 – 555 Ma) weakly deformed calc-alkaline metaluminous to slightly peraluminous Galiléia granitoids (0.97 < A/CNK < 1.07; SiO_2 62 – 72 wt.%; CaO 2.8 – 6.1 wt.%) host widespread magmatic garnet and epidote, indicating crystallisation in the lower crust (ca. 25 – 30 km). The Galiléia granitoids are identical in major element composition to typical I-type granitoids. Textural and mineral chemical evidence suggest two generations of garnet: the first show grossular (Grs) increasing from core to rim, from 25 to ca. 40 mol.%, whereas pyrope (Prp) and almandine (Alm) decrease from 7 to 2 mol.% and from 59 to 48 mol.%. Spessartine (Sps) is barely flat varying from 10 – 14 mol.%. In these rocks, garnet has δ18O = 9.7 ‰ and quartz has δ18O = 13.4 ‰. The second generation of garnet is most common and textures indicate that it crystallised later than type 1. These crystals are largely unzoned, with Grs, Prp and Alm varying from crystal to crystal, from: 25 to 43 mol.%, 2 to 3 mol.% and 40 to 51 mol.%, respectively. Garnet has lower δ18O values, between 7.6 and 8.2. Quartz δ18O in these rocks ranges from 12.0 and 12.7 ‰. Preliminary REE profiles analyses on a few separated type 2 garnet crystals show positive Eu/Eu* anomaly (1.6 - 3.3) different from the bulk rock (Eu/Eu* = 0.6). Δ(quartz-grossular) values range from 3.8 to 5.0 ‰ consistent with O-isotope equilibrium between 500 to 625°C. These subsolidus temperatures probably reflect oxygen exchange between quartz, feldspar and epidote down to closure temperatures of 550 – 500°C, after garnet closed to O diffusion. Garnet Grs and δ18O values do not appear to vary as a function of whole rock composition (e.g. SiO_2, CaO and La/YbN) and garnet δ18O values fall within the range recorded by similar magmatic crystals (δ18O 6 to 11.6 ‰ from other metaluminous intermediate to felsic magmas. Combined with the negative zircon εHf (-6 to -14), garnet δ18O values suggest that the Galiléia magmas arose through high pressure anatexis of a meta-igneous crustal source of intermediate to felsic composition. From the few crystallisation experiments using metaluminous systems similar to that of the Galiléia granitoids, only experimental low T (ca. 650°C) magmatic garnets (Grs26-29Alm58-63Prp12-16Sps2-3) have a composition close to the Galiléia garnets (Grs25-43Alm40-59Prp2-7Sps9-19). A possible explanation might be that at low temperatures (< 700°C), experiments do not reach equilibrium, due to low garnet-feldspar diffusion. Late Galiléia garnet crystals form by consuming plagioclase close to the solidus. Due to the small-scale chemical equilibration domains, garnet REEs cannot be fully equilibrated. Thus the positive Eu/Eu* anomaly in late garnets might be partially inherited from plagioclase.