Influence of inclusions and leaching techniques on Sm-Nd and Lu-Hf garnet chronology

ROBERT ANCZKIEWICZ[1,2] MATTHEW THIRLWALL[2] AND JOHN PLATT[1]

[1]University College London, Gower Street, London WC1E 6BT, UK (rob@gl.rhul.ac.uk)
[2]Royal Holloway University of London, Egham, Surrey TW20 OEX, UK (m.thirlwall@gl.rhul.ac.uk)

Sm-Nd chronology is often affected by REE-rich inclusions, which lead to ambiguous ages, lower precision or make dating impossible. In order to investigate this problem we conducted Lu-Hf and Sm-Nd garnet dating on a high pressure granulite, a felsic subvolcanic intrusion and a high grade metapelite. We propose a new leaching technique capable of substantially reducing or even eliminating phosphate inclusions.

Lu-Hf and Sm-Nd dating of high pressure garnet granulite from Kohistan region of Pakistan yielded concordant ages of 94±1.2 and 95.9±2.6 Ma respectively. Small variations in both $^{176}Lu/^{177}Hf$ and $^{147}Sm/^{144}Nd$ ratios among 3 garnet fractions result most likely from small amount of amphibole contamination. Dating of the subvolcanic intrusion from Lanarkshire (Scotland) gave a Lu-Hf age of 419±19 Ma, concordant with the 411±2 Ma Sm-Nd age of Thirlwall (1988). Poor precision of Lu-Hf age is caused by very limited spread in $^{176}Lu/^{177}Hf$ ratios (0.7). Similarly the metapelite garnet from N. Vietnam was strongly affected by inclusions and yielded $^{147}Sm/^{144}Nd$ ratios too low to determine an age. Metapelite garnets, which were very rich in monazite, zircon and apatite inclusions, were subjected to leaching experiments.

We modified the leaching procedure of Amato et al. (1999). Two leaching steps with concentrated HF, followed by 6N HCl yielded $^{147}Sm/^{144}Nd$ ratios of 0.97 and 1.08, respectively. The remaining residue gave a low Sm/Nd ratio due to strong contamination by inclusions undissolved at earlier steps (as indicated by a very high Nd concentration). Two other garnet fractions from the same sample treated with concentrated H_2SO_4 and subsequently fully dissolved gave identical, very high $^{147}Sm/^{144}Nd$ of 1.97.

All points from both experiments plotted on a single errorchron of age 41.8±4.3 Ma (MSWD = 3.4 and probability of fit = 0.02). The poor statistics are caused by the HF leachate analysis, during which some Nd was leached from inherited monazite and zircon inclusions. After removing this point from the regression an isochron age of 41.7±1.5 Ma is obtained with MSWD = 0.057 and probability of fit = 0.94.

Our data demonstrates that H_2SO_4 leaching can effectively remove phosphate inclusions enhancing precision and reliability of Sm-Nd garnet chronology.

References

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Geochemistry and Geochronology of Basement Rocks from the Pelagonian Zone, Greece

B. ANDERS[1,2], T. REISCHMANN[1,2] AND U. POLLER[2]

[1] Dep. of Earth Sciences, Johannes Gutenberg-University, Mainz, Germany (banders@mail.uni-mainz.de)
[2] Max-Planck-Institut of Chemistry, Dep. of Geochemistry, Mainz, Germany

The Pelagonian Zone forms a major crustal entity within the Central Hellenides. It is located between the Serbomacedonian Massif and the Rhodope Massif (Internal Hellenides) to the east and the Pindos Zone (External Hellenides) to the west. The prevailing rock types of the Pelagonian Zone are granitic and minor mafic gneisses, presumably Mesozoic carbonates, ophiolites and Palaeocene Flysch.

In our study we concentrated on basement rocks, especially on the orthogneisses. These orthogneisses show variable deformation ranging from almost undeformed rocks with a granitic texture to highly sheared gneisses. Augengneisses are common with feldspar “augen” up to several centimeters in size. Despite their variable deformation the ages of the rocks are rather homogenous indicating a Permo-Carboniferous crust-forming event at 280-300 Ma. These ages were obtained by single zircon analysis using the Pb/Pb evaporation technique and were later confirmed by single zircon U-Pb-dating. Cathodoluminescence imaging of the zircons from the dated samples showed the magmatic oscillatory zoning indicating an igneous origin of these zircon grains.

Based on the geochemical composition the orthogneisses are classified as Syenogranite, Monzogranite or Granodiorite, only some are Monzodiorites and Monzogabbros. Using geochemical parameters such as the Fe*-number, the aluminium saturation index and the modified alkali index most of the basement rocks are characterized as slightly peraluminous and magnesian. They belong to an alkalic-calcic to calcic suite. Based on the low concentrations of HFSE such as Nb and Y the granitoid rocks of the Pelagonian Zone are identified as volcanic arc or collisional granitoids.

Sr isotope analysis gave $^{87}Sr/^{86}Sr_{(300)}$ initial ratios ranging from about 0.703 to 0.705. Such low Sr ratios indicate a mantle source, from which the magmas were derived, such as the depleted mantle with only small contributions of older continental crust. The geochemical and isotopic data support the model that the basement rocks of the Pelagonian Zone formed as part of a magmatic arc in a subduction zone environment during the Upper Carboniferous/Lower Permian.