Magma mixing and mingling textures and geochemistry of microgranular enclaves in granitoids of SE Semnan, N Iran

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Discussion

Many granitoid intrusions display textural and geochemical evidence for the intraction of mafic and silisic magmas during their genesis [1]. The post-middle Eocene granitoids from SE Semnan, N Iran have many fine grained mafic microgranular enclaves, with diameters between 1 to 15 cm. Their composition varies from monzonite, quartzmonzodiorite – monzodiorite and monzogabbro – and exhibites evidence for magma mixing and mingling both at outcrop and at thin sections. These textures are antirapakivi feldespare, acicular and prismatic apatites, inclusion of mafic zones in feldspares, spongy cellular plagioclase, reverse zoning in plagioclases and etc.. In host granitoid rocks there are also two types of biotites in composition (that one types have high TiO_2, Al_2O_3 , MgO and low SiO_2, are similar to contents of these elements in mafic microgranular enclaves and second types are depleted in TiO_2, MgO and enriched in Al_2O_3 and SiO_2) and reverse plagioclases zoned. The magmatic origin of enclaves is suggested by their typical igneous textures, such as with abundant acicular apatite, elongate zircon, the euhedral form of the mafic phases, porphyritic texture and plagioclase zoned [2]. These observations suggest that the mafic microgranular enclaves are derived from a hybrid magma formed as a result of the intrusion of mafic magma into the base of a felsic magma chamber.

Conclusions

The mafic microgranular enclaves have igneous mineralogy and textures. The petrographic, chemistry of minerals and whole-rock geochemical relations, in the mafic microgranular enclaves and their host rocks, indicate that magma mixing and mingling played a important role during their evolution .

References

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Carbonate clumped isotope thermometry of molluscs and its applications to Pleistocene gastropod fossils from South Dakota

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Ghosh *et al.*, (2006) [1] present a carbonate clumped isotope palaeo-thermometer. Otolith aragonite from fishes collected over a range of known temperatures [2] validates the original calibration of this thermometer for inorganic calcite precipitate (ICP) and coralline aragonite [1]. Here we present a calibration for molluscs, including gastropods collected from nature and inferred to have grown at widely different temperatures (2-25°C). The growth temperatures for these samples were estimated based on mean annual temperature (MAT) at the site of collection. We speculate that these growth temperature estimates could be biased by unknown and possibly variable amounts to due seasonality of growth and/or other factors. Despite these uncertainties, the mean trend in the relationship between inferred growth temperature and $^{13}C^{18}O^{16}O$ content of CO_2 extracted from mollusks is indistinguishable from that previously documented for ICP. The proportionality for molluscs can be described between 1 and 25 ˚C by the function: $\Delta_{47} = 0.0603.10^6 \cdot T^{-2} - 0.0496$, where Δ_{47} is the enrichment, in per mil, of $^{13}C^{18}O^{16}O$ in CO_2 relative to the amount expected for a stochastic (random) distribution of isotopes among all CO_2 isotopologues [3,4], and T is the temperature in Kelvin. However, due to scatter in these new data, we suggest that the statistically indistinguishable and more precisely known trend for ICP should be used for molluscs.

We apply the carbonate clumped isotope thermometer to gastropods (*Physella*) deposited concurrently with mammoth skeletons in a sinkhole deposit in South Dakota, USA. The age of deposition of the analyzed samples was 26,075±880 years BP, based on ^{14}C dates for bone apatite collected from the same strata [5]. We analyzed aragonite powder from 15 *Physella* shells collected from various depths across a 255 cm vertical section from this location. Our results provide an estimate of 31.2±3.34°C for the average temperature of water at the time of deposition. The average $\delta^{18}O$ value of sinkhole water was (calculated assuming an equilibrium fractionation of ^{18}O between carbonate and water [6]) -10.5±0.66‰. We estimated MAT using a combination of modern day MAT and $\delta^{18}O$ of rainfall from the same area. Our results suggest that the average temperature in the area was 4.3°C colder at the time of deposition than it is today.

References

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