5.5.24

P-T paths in crustal enclaves: Examples from the Neogene Volcanic Province, Spain

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Crustal enclaves in felsic lavas may provide important constraints on the prograde P-T path of the source region. By contrast, the uplift path is likely to reflect magma transport rather than uplift and exhumation of the lower to middle crustal source level. Complications may arise when the magma incorporated material from multiple source levels and from wall-rock of the magma conduit.

In this work we describe reaction textures from metapelitic restites in the Neogene Volcanic Province (NVP) of SE Spain, focussing on El Hoyazo and Mazarrón zones. For each of the two enclave suites we present qualitative pseudosections for (i) low-Mg, low-Al protoliths; (ii) high-Mg, low-Al protoliths; (iii) low-Mg, high-Al protoliths; and (iv) high-Mg, high-Al protoliths. Thermobarometry shows that El Hoyazo samples equilibrated at 6-7 kbar, 850-900 ^{o}C [1], whereas Mazarrón samples equilibrated at 4-5 kbar, 750-800 ^{o}C [2].

The P-T evolution before peak metamorphism is characterized by sub-isobaric heating, causing dehydration melting. In many samples, a fibrolite-rich foliation wraps incongruent phases, possibly reflecting volumetric strain due to melt loss. All solid phases, even reactants, incorporate melt inclusions, suggesting pervasive annealing. Rare wall-rock enclaves equilibrated at significantly lower T and lack partial melting reactions. Many xenoliths show patches of Spl ± Crd ± Kfs overprinting the fabric. Pseudosections and reaction line slopes suggest that they formed during sub-isothermal decompression, attributed to magma transport.

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5.5.25

Potential minerals for determining U-Th-Pb chemical geochronology using the electron microprobe

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The electron-microprobe (EMP) dating method has, over the past decade, been successfully applied to monazite for the emplacement of associated granitoids. The advantages of this method are mainly that: (1) it is a true in situ high spatial resolution method —the analysed area is two orders of magnitude smaller than that required by the ion microprobe, which enables one to avoid defaults and inclusions when dating polygenetic grains; (2) it is a non-destructive method; (3) all the stoechiometric components are also analysed; (4) direct dating on thin section is possible, providing constraints related to ages; and (5) it is inexpensive. Its weaknesses are that: (1) it is not a very precise and sensitive method —some hundreds of ppm are required; (2) it is not an isotopic method —common lead must be negligible compared to radiogenic lead; and (3) Pb diffusion, if any, cannot be directly controlled. Nevertheless, many recent studies have demonstrated that the method can be precise and accurate for monazite [1] and that common-Pb is really negligible. In addition, it has also been demonstrated that Pb diffusion in monazite is weak [2, 3] except in altered domains, which can be avoided after back scattered electron study.

Here we review six accessory U- and/or Th-enriched minerals that we tried to date like monazite, i.e. zircon, allanite, thorite, xenotime, baddeleyite, thorianite. When possible the results were checked by conventional isotopic methods.

In conclusion, we find that (1) monazite and thorianite are the most suitable minerals for calculating reliable ages from U-Th-Pb determinations using the electron-microprobe, (2) the EMP method is of limited interest for zircon and allanite because of the usually too low total amount of Pb for EMP analysis and because common Pb is often fairly significant, (3) the EMP method is the only one that can date rare minerals such as baddeleyite and xenotime, and finally (4) tested thorites usually show huge radiogenic Pb loss due to their altered state.

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