

## $^{40}\text{Ar}/^{39}\text{Ar}$ age constraints for the D2 Variscan extension in the Porto-Viseu metamorphic belt (Portugal)

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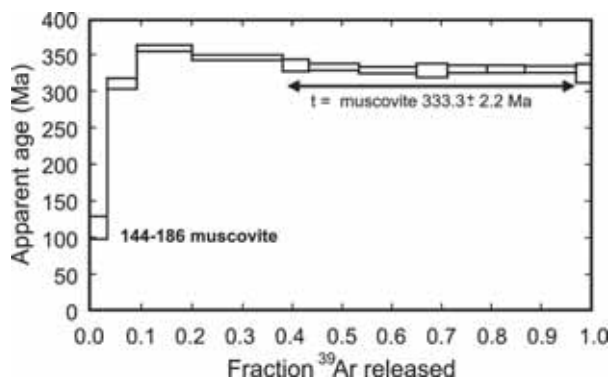
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The Porto-Viseu belt is located in the innermost zone of the Iberian Variscan Belt. During the Variscan continent – continent collision (370-290 Ma), this area was affected by three main deformation events (D1, D2 and D3). The earlier D1 deformation phase affected all the pre-Carboniferous sedimentary sequences and induced prograde metamorphism of Barrovian type, characterized by a rapid increase of metamorphic grade from the chlorite and biotite zones to the staurolite, sillimanite and sillimanite+K-feldspar zones.

The D1 NW-SE trending contractional structures were variably overprinted by a major syn-collisional D2 extensional event attributed to a gravitational collapse of the thickened continental crust. The metamorphic climax, accompanied by intense migmatization is reached during this tectonic event. Late stage D3 deformation is related to crustal-scale transcurrent shear zones and marks the beginning of extensive plutonic activity represented by large volumes of syn- and late-D3 granitoids.

This work presents new geochronological  $^{40}\text{Ar}/^{39}\text{Ar}$  data for D2. The data were obtained in muscovite concentrates from one metapelite sample (144-186) from the staurolite zone showing a strong S2 fabric. The muscovite concentrates yield a  $^{40}\text{Ar}/^{39}\text{Ar}$  plateau age of  $333.3 \pm 2.2$  Ma (Figure 1). This age is coherent with regional structural constraints and with the available U-Pb geochronological data for the syn-D3 granites from the area (308 Ma). The  $333.3 \pm 2.2$  Ma age appears therefore to date the D2 event.



**Figure 1:** Muscovite  $^{40}\text{Ar}/^{39}\text{Ar}$  analytical results.

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## Imagery-correlated high precision stable isotope analysis

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The CAMECA IMS-1280 large radius, multicollector ion microprobe at the Wisc-SIMS National Facility is capable of high accuracy and precision for *in situ* analysis of isotope ratios. Spot size is variable from ~10 to sub-micron as dictated by counting statistics and desired precision, which can be as good as  $\pm 0.1\%$  (1sd) for  $10\mu\text{m}$  spots and better than  $\pm 1\%$  for sub- $\mu\text{m}$  spots on  $\delta^{18}\text{O}$  [1]. Analysis is correlated to textures as seen by a range of imaging techniques. These new capabilities permit exciting and fundamental research where samples are small, precious, or zoned. For instance:

1. Laser confocal microscopy reveals annual layers in speleothems from Soreq Cave, Israel. Correlated analysis of  $\delta^{18}\text{O}$  detects long term changes in seasonality at 0.1y resolution, vs. >10y by previous methods [2].
2. Igneous zircons with 1-70 ppm Li have growth zoning, imaged by CL and by maps of ppm [Li]. Values of  $\delta^7\text{Li}$  (and total REE) correlate to growth bands demonstrating that values are magmatic [3].
3. Growth zones in single forams (SEM) analyzed for  $\delta^{18}\text{O}$  with <math>3\mu\text{m}</math> spots reveals up to 3% zoning between ontogenetic and gametogenetic calcite demonstrating two vital effect mechanisms that are opposite in sign [4].
4. Carbonate globules in the Mars meteorite, ALH84001, are concentrically zoned in Ca-Mg-Fe-Mn (EMPA). Values of  $\delta^{18}\text{O}$  correlate with chemistry, while  $\Delta^{17}\text{O}$  is constant at 0.8 for carbonates and  $0.3 \pm 0.1$  for opx [5].
5. In chondrules from Semarkona,  $\delta^{18}\text{O}$  vs.  $\delta^{17}\text{O}$  slopes of ~0.5 are resolved within apparently MIF arrays [6].
6. CL imaging of quartz overgrowths in St. Peter sandstone (SW Wisconsin) reveals multiple layers of finely banded cement. However, analysis of  $\delta^{18}\text{O}$  shows that these cements are homogeneous at 29.3% suggesting that these syntaxial overgrowths formed in the vadose zone as deep silcretes [7].
7. Analysis of 2mm bluegill otoliths resolves seasonal changes of  $\delta^{13}\text{C}$  in daily growth layers (SEM). A sharp  $\delta^{13}\text{C}$  increase of ~10% during a whole-lake  $^{13}\text{C}$  labelling experiment shows that a larger proportion of otolith carbon is derived from DIC than diet (M~0.4) [8].

[1] Page *et al.* (2007) *Am Min* **92**, 1772-1775. [2] Orland *et al.* (2008) *GCA*, this vol. [3] Ushikubo *et al.* (2008) *GCA*, this vol. [4] Kozdon *et al.* (2008) *GCA*, this vol. [5] Valley *et al.* (2007) *Lun Sci Conf* **38**, #1147. [6] Kita *et al.* (2007) *Lun Sci Conf* **38**, #1791. [7] Kelly *et al.* (2007) *GCA* **71**, 3812-3832. [8] Weidel *et al.* (2007) *Can J Fish Aquat Sci* **64**, 1641-1645.