Dating crocidolite deposits using the argon-argon-method

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Understanding the mechanisms and geological framework of crocidolite formation is a matter of debate and often hampered by a precise knowledge of its formation age. To address this issue, we have dated a series of crocidolite (amphibole asbestos) samples from the Asbesheuwels Subgroup (Griqualand West, South Africa) using the Ar-Ar technique. At very low K-contents (0.01 – 0.20 wt% K), between 6 and 30 mg of fiber bundles were measured by laser induced step wise heating on a ARGUS noble gas mass spectrometer.

Resulting ages span a large range between 2.13 and 1.22 Ga at relatively well developed plateaus, from which some of them indicate diffusive Ar loss. The crocidolite ages therefore did not reflect a single event, but a series of post-formation thermal overprints that may have disturbed the K-Ar system. Although no closure temperature is reported for crocidolite, we assume it to be similar to other amphiboles (~500-550°C) and thus interpret the oldest age (2.13 ± 0.02 Ga) as formation age of the crocidolite deposit. This is slightly younger than the age of the banded iron formation (2.5 - 2.4 Ga). Several of our Ar-Ar ages range between 1.63 ± 0.02 and 1.87 ± 0.02 Ga (4 samples) and are most likely related to the Kheis event, during which the Congo Craton collided with the Kaapvaal Craton [1]. The youngest age preserved by one sample (1.22 ± 0.02 Ga) most likely reflects a thermal resetting during the Namaqua-Natal-orogeny at about 1.4 - 1.0 Ga [1].

In conclusion, crocidolite is a suitable phase to be dated by the Ar-Ar technique. Interpretation of ages, however, is hampered by the fact that the retentivity behavior of Argon in crocidolite during thermal overprints is unknown and that the conditions of crocidolite formation itself are poorly understood.

[1] McCarthy, T., Rubidge, B. (2005): *The Story of Earth and Life – A southern African perspective on a 4.6-billion-year journey,* Struik, Singapore.

Sr isotopic composition of manganese nodules: Recorder of Cambrian ocean

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The rapid increase in seawater Sr isotopic composition at the start of the Paleozoic era is attributed to the onset of intensive weathering of the Pan-African orogen. A potential recorder of this significant change is found in Cambrian Mn ores in southern Israel. However, because these ores experienced several stages of dissolution, mobilization and alteration, the timing of their formation is in dispute. Two different generations of Mn nodules (types A and B) were recognized in previous studies [1]. Sr isotope measurements reveal that Type A Mn nodules have a constant value of the $^{87}Sr/^{86}Sr$ ratio (0.7089 ± 0.0005), whereas type B Mn nodules show a wide range (0.709 to 0.716). A composite seawater Sr isotope curve [2] places the Type A Mn nodule values in the lower Cambrian period (*ca*. 550Ma), and hence reinforces their Cambrian origin. This finding agrees with field observations, metal ratios and Eh-pH calculations, which show that Type A Mn nodules formed at the sediment-water interface under oxidizing conditions [1]. In contrast, the high $^{87}Sr/^{86}Sr$ ratios of Type B nodules indicate post-deposition processes that involved radiogenic solutions. The current study indicates that Mn nodules can retain oceanic Sr isotopic ratios, even where they experience complex alteration events. It is, however, essential that the field, petrographic and mineralogical relations are determined.

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