A New Approach of Unspiked K-Ar Dating Using Laser Fusion on Microsamples

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Abstract： Issues induced by neutron irradiation makes $^{40}Ar/^{39}Ar$ dating inapplicable in some cases. The first issue is ^{37}Ar and ^{39}Ar recoil effects during irradiation that affect fine-grained minerals (<50mm), such as lunar rocks, glassy groundmass, supergene minerals (e.g. illite, glauconite, Mg-oxide etc.). The second issue from neutron irradiation is high radioactivity gain of iron-rich samples such as pyrite. The third issue is the production of interference nuclides during irradiation. Inherent drawbacks of conventional K-Ar and current unspiked K-Ar dating make it difficult to assess the reliability of age results. A new approach is proposed using well-calibrated $^{40}Ar/^{39}Ar$ standard minerals to directly quantify ^{40}Ar, ^{38}Ar and ^{36}Ar. FCs sanidine, B4M muscovite and MMhb-1 hornblende, the widely-used international standard minerals, were analyzed as unknowns to test the approach. Argon isotope analyses were carried out on a noble-gas mass spectrometer using laser fusion on microsamples (n × 0.01 to n × 0.2 mg). A new isochron - an "inverse isochron" for K-Ar dating - is designed. FCs and B4M yielded apparent and inverse isochron ages of 28.1 ± 0.1 and 28.0 ± 0.3Ma, 18.2 ± 0.1 and 18.2 ± 0.5Ma, which are consistent with the recommended ages, while the MMhb-1 presented lower apparent and inverse isochron ages (510.8 ± 4.8 and 512.3 ± 17.0Ma) than the recommended ones. The initial argon compositions for the three standard minerals are 299.2±205.3 (FCs), 294.0 ± 16.4 (B4M) and 290.9 ± 203.1 (MMhb-1) agreeing with that of air. The approach potentially overcomes the issues of $^{40}Ar/^{39}Ar$ rising from irradiation and drawbacks of K-Ar. By using laser fusion on multiple microaliquots from a same sample, this approach can produce accurate and precise K-Ar ages and give an inverse isochron. The new approach may provide an alternate dating method of geochronology based on argon isotopes.

Keywords: a new approach, unspiked K-Ar dating, laser fusion, microsample, inverse isochron

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