In situ K/Ar geochronology using simultaneous LIBS and noble gas mass spectrometry

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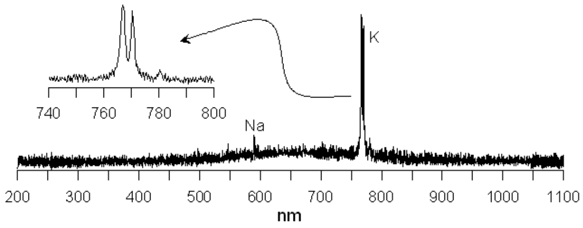
The K/Ar method is one of the most versatile gochronological tools. For some applications it has been superseded by the Ar/Ar method. The advantages of the latter are much better sample homogeneity, revelation of thermo-chronological histories (not always fulfilled), single crystal dating and *in situ* sampling by laser ablation. Although we have made hundreds of successful K/Ar analyses in milligram-size samples with a CO_2 laser at our laboratory, the classical K/Ar technique has not been pushed much further.

Laser-induced breakdown spectroscopy (LIBS) has been used for three decades for obtaining chemical information of gases, liquids and solids. The number of applications with this method has grown largely in the past ten years due to the availability of relatively inexpensive nanosecond pulsed lasers and sophisticated spectrographs and detectors.

In situ argon geochronology is only feasible with the Ar/Ar method, because it is difficult to know the amount of K ablated to apply the classical K/Ar chronometer. Nevertheless the plasma generated during ablation can be sampled with a suitable spectrograph and the amount of K determined for the same volume to be analyzed for argon. One of the limitations of quantitative LIBS – the signal strength of each element is related to the sampled weight (or volume), among other variables – is here an advantage. We will show the first experiments of this method in a modified form, using a CW-CO_2 laser with millisecond “pulses” obtained with RF excitation. This method has never been tested before, but in a biotite sample the main K lines at 766.5 and 769.9 nm are clearly visible (see figure). Almost no other element has been excited due to the relatively low irradiance of the laser “pulse”. This combined technique is very promising and with some important modifications it will be also applicable to the (U-Th)/He dating in the future.



Geochemistry and isotopic studies of the Kashmar batholith, NE Central Iran Plate (CIP)

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The Kashmar batholith (43-42 Ma) located between 35°15′–35°25′ N and 58°15′–58°55′ E, covers an area ~200 km^2, and intrudes into genetically related andesitic lavas and pyroclastic rocks (mainly tuff) of Early Eocene age. The batholith together with associated volcanic rocks constitute the central part of an iron-oxide type magmatic belt that forms the northeastern part of the CIP. The batholith includes tonalite, granodiorite, granite and alkali feldspar granite plutons that have metaluminous (ASI $\leq$ 1) I–type characteristics. These rocks are chemically high in Na_2O, K_2O, Al_2O_3, total Fe as Fe_2O_3, and low in CaO, MnO, P_2O_5, TiO_2 and MgO contents. They show linear trends on Harker plots, enrichment in most LFSE and LREE but depletion in HFSE compared with primordial mantle values, steep negative slopes for LREE, moderate to strongly negative anomalies for Eu (Eu/Eu* = 0.88–0.18), flat to slightly negative gradients for HREE, and parallel trends for spider diagrams and REE patterns. Samples from the batholith have low initial $^{87}Sr/^{86}Sr$ (0.70471–0.70569), intermediate initial $^{143}Nd/^{144}Nd$ (0.512502–0.512548) and low, negative ε_{Nd} (–0.70 to –1.86) values. Thermo–barometric data for Ca–amphiboles from the Kashmar batholith suggest low T (617–700°C), low P ($\leq$3 kbar), and fO_2 higher than QFM. These geochemical data indicate that plutons of the Kashmar batholith represent a *simple suite* of low–temperature I–type granites. In addition, the data suggest that the magmas were generated by partial melting of infra–crustal source rocks and evolved dominantly through the mechanism of fractional crystallization.