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Graphical Solutions to the Problem of Radiogenic Argon-40 Loss from Metamorphic Minerals, a Comment

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In a recent paper C. T. Harper (1970) suggests a method of plotting potassium-argon data which might reduce the commonly observed discordance between potassium-argon dates from metamorphic micas and the true time of crystallisation as derived by other means. The method involves plotting argon-40 content against potassium-40 content. In an ideal closed-system case, samples of the same age but with different potassium contents will plot along a line (or isochron) which passes through the origin and whose slope is proportional to the age of the samples. If it is supposed that all samples, whatever their potassium content, have lost an identical volume of radiogenic argon then their analyses plot along a line parallel to the closed-system isochron, but with a negative intercept on the argon-40 ordinate. This intercept indicates the volume of argon-40 lost. Such is Harper's graphical solution. It is questionable whether such a simple hypothesis could apply to natural rock systems since it does not take into account variations in argon retentivity caused by differences in grain size and chemical composition, but such is not the purpose of this communication.

Harper seeks to gain support for his hypothesis by citing examples from the Scottish and Irish Caledonides and from the northern Appalachians. He admits that "the scatter of data is in some cases more than desirable", but suggests that "the results do illustrate the feasibility of using isochron-type plots for K^{40}-Ar^{40} data presentation".

Unfortunately the plots presented in Figures 6, 7 and 8 are far from convincing when the reference isochrons are removed from the diagrams. A single straight line can be drawn through, or close to, all the points in Figure 7, going through the origin. No criteria are proposed for selecting which biotites and muscovites in this figure should belong to which isochron.

Figure 5, on the other hand, is a very plausible plot, with whole-rock analyses of slates and phyllites lying on a 503 m.y. isochron with zero intercept, and analyses of micas lying on a parallel isochron with a negative intercept. Hypothesis proved? Not so. Figures 5 and 6 are both from the Scottish Caledonides. Harper states unequivocably (p. 132) that the two groups of micas "appear indistinguishable on the basis of either stratigraphic, structural or geographic criteria". When all mica analyses in Figures 5 and 6 are plotted on one diagram (as can be done easily using tracing paper) they form a single group of points, with sufficient scatter to make it quite uncertain as to whether the best fit line would have a positive or negative intercept. There is no suggestion from the distribution of points that the micas from Figure 5 should be plotted separately from those of Figure 6.

It would appear that the ten mica analyses in Figure 5 have been selected merely to fit the theory and for no geological or geochronological reason. Figure 5 must thus be rejected. The remaining data gives little support to the hypothesis.

REFERENCE

HARPER, C. T. (1970): *Graphical Solutions to the Problem of Radiogenic Argon-40 Loss from Metamorphic Minerals*. Eclogae geol. Helv. *63*/1, 119–140.