$^{40}Ar/^{39}Ar$ data on primary and secondary minerals of a volcanic series affected by burial metamorphism: example of a Cretaceous Andean extensional basin

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Precise time constraints on both the formation of magmatic rocks and subsequent alteration or very low-grade metamorphism are difficult to obtain on the same rocks, mainly because of the difficulty to separate uncontaminated mineralogical components relative to these two events.

We initiated a $^{40}Ar/^{39}Ar$ study on a thick Lower Cretaceous basaltic sequence in a regional subsiding basin affected by a very low to low-grade metamorphism due to burial, with the aim to obtain reliable ages on primary minerals (volcanism) and secondary phases (metamorphism) permitting to define the time interval between volcanism and burial metamorphism.

The 9 km thick series, located at the latitude of Santiago, is part of a.c. 1000 km long volcanic belt of Early Cretaceous age exposed along the Coastal Range of central Chile (see more details in Aguirre *et al.*, 1989). Most of the basic lavas belong to the high-K calc-alkaline and shoshonite series. The rocks have been affected by very low- to low-grade, non deformational metamorphism, which preserved the primary structures and textures. Its grade increases with stratigraphic depth ranging from zeolite facies at the top to lower greenschist facies at the very bottom of the pile. Characteristic metamorphic assemblages in zeolite and prehnite-pumpellyite facies are: (a) laumontite + chlorite + pumpellyite + prehnite + epidote + K-feldspar and (b) pumpellyite + epidote + chlorite + prehnite + K-feldspar.

The various characteristics of the series and of its geologic framework have been interpreted by different authors as representing an extensional ensialic setting either of a marginal basin or of an island arc type.

Transparent plagioclases in bulk samples and single grains of phenocrysts, and the freshest whole rocks were carefully selected to provide the best estimate of the age of the volcanism. Adularia single grains, filling amygdales (together with pumpellyite, chlorite and low albite), and cloudy single grains of plagioclases (contaminated by secondary sericite, K-feldspar and albite) were analysed to obtain the age of the metamorphism.

Previous dating by K/Ar, $^{40}Ar/^{39}Ar$ and Rb/Sr displayed ages mainly ranging from 100 to 134 Ma (Äberg *et al.*, 1984; Munizaga *et al.*, 1988; Boric and Munizaga, 1994).

The plagioclase bulk sample displayed a disturbed age spectrum because we failed to obtain uncontaminated phases on several hundreds of grains. Concordant plateau age (119.4 $\pm$ 1.2 Ma) and high temperature apparent ages were obtained on a restricted population (29 and 37 grains, 96BU6 on Fig. 1) and single phenocrysts of transparent plagioclases. This represents the best estimate of the age of the volcanism.

Adularia single grains gave a well defined plateau age at 93.1 $\pm$ 0.3 Ma on one grain (96BU10 in Fig. 1) and slightly increasing apparent ages (probably due to a slight alteration) converging towards a value of 94.2 $\pm$ 0.6 Ma on another grain. This corresponds to the age of the very low-grade metamorphism.

Between these extreme values characterizing the two events, intermediate apparent ages were obtained

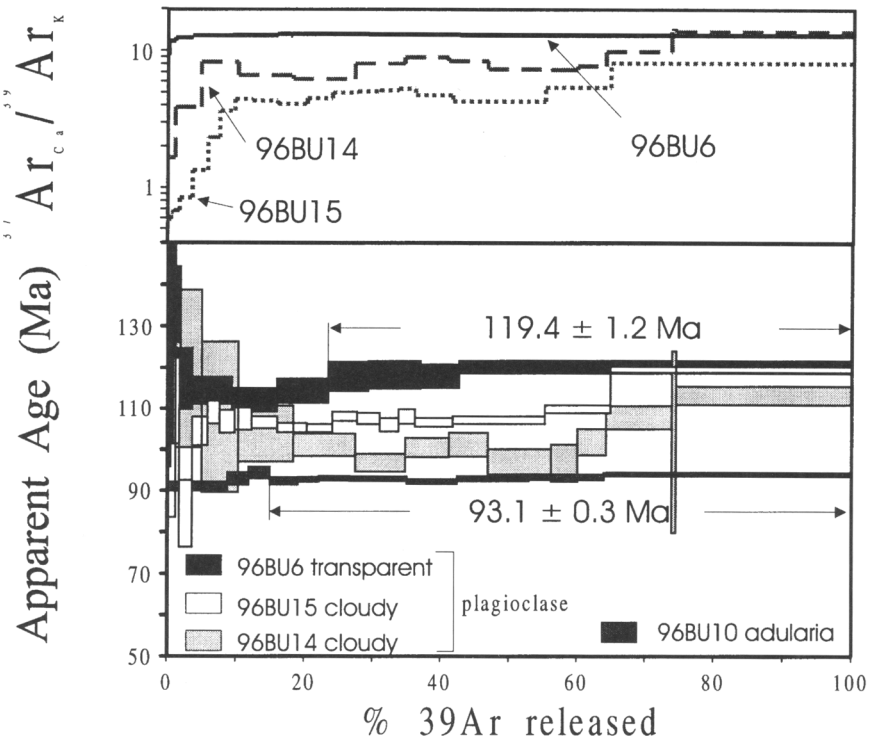

FIG. 1.

on cloudy single grains of plagioclase (96BU14-15 in Fig. 1). A clear correlation between the apparent ages and the ratio Ca/K deduced from the $^{37}Ar_{Ca}/^{39}Ar_K$ ratio (see Fig. 1) shows that the purest plagioclase phases (high Ca/K, similar to the ratio measured by the microprobe on pure plagioclase) approach the plateau age of 119 Ma, whereas the more contaminated phases (in K) are younger.

It was surprising to observe that (1) one whole rock displayed a plateau age of 91.5 ± 0.4 Ma, not very different from the adularia ages, despite the fact that it was the less altered sampled rock, and (2) one other whole rock, from which the plagioclase displaying the best estimate of the volcanism age (96BU6, 119 Ma) was extracted, gave apparent ages around the age of metamorphism.

References

Åberg, G., Aguirre, L., Levi, B. and Nyström, J.O. (1984) In: Kokelaar, B.P. and Howells, M.F., eds., *Volcanic and associated sedimentary and tectonic processes in modern and ancient marginal basins.* Geol. Soc. Lond. Sp. Publ., **16**, 185–93.

Aguirre, L., Levi, B. and Nyström, J.O. (1989) In: Daly, J.S., Cliff, R.A. and Yardely, B.W.D., eds., *Evolution of metamorphic belts. Geol. Soc. London Sp. Publ.*, **43**, 223–32.

Boric, R. and Munizaga, F. (1994) *Comunicaciones*, **45**, 135–48.

Munizaga, F., Holmgren, C., Huete, C. and Kawashita, K. (1988) *V Congreso Geológico Chileno*, Santiago, T - III, 177–93.