The age and thermal evolution of blueschists from South-East Sulawesi, Indonesia: the case of slowly cooled phengites

J.R. Wijbrans *Faculty of Earth Sciences, Vrije Universiteit Amsterdam*
H. Helmers
J. Sopaheluwakan *Centre for Geotechnical Research and Development, Indonesian Institue of Sciences, Bandung.*

The southeast Sulawesi blueschist belt consists of graphite-mica schists and blastophitic metabasites of MORB-affinity. The belt is part of the continued interaction of subduction and collision processes that characterise the tectonic history of southeast Asia since the late Mesozoic. Metamorphism is of the HP-LT type with maximum temperatures of *c.* 400°C and a maximum pressure estimates of *c.* 1.0 GPa, which are considered to be indicative for rapid tectonic movement or significant advective cooling due to ongoing subduction in the immediate vicinity.

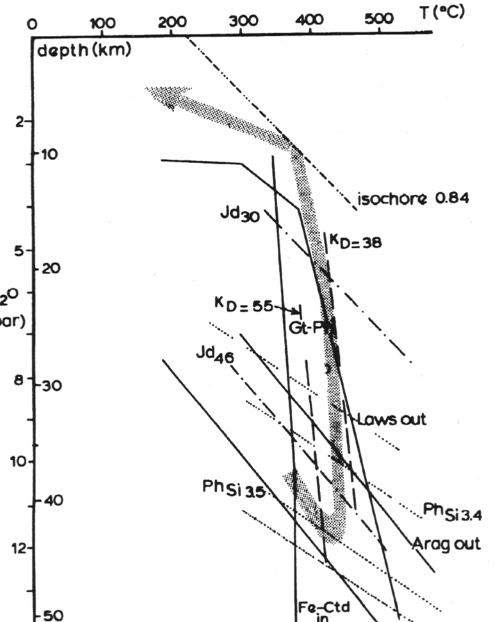

FIG. 1. P-T loop for the Sulawesi blueschists showing limiting mineral reactions. Laws is lawsonite, Jd is Jadeite, Ph is phengite, Si3.5 is Si content of phengite per formula unit. Arag is aragonite, K_D for garnet-phengite of 55 and 38 limit the maximum temperature to *c.* 400°C.

Four mineral parageneses that occur in the mica schists:

1. phengite-quartz-chloritoid-glaucophane-lawsonite-garnet-ilmenite-pyrite,
2. phengite-quartz-lawsonite-garnet-albite-pyrite,
3. phengite-quartz-carbonate-lawsonite-garnet-sphene,
4. chlorite-albite-muscovite-sphene-quartz-oxychlorite.

In combination with microstructural criteria they can be related to prograde, peak and decompression stage of a simple PT loop (Fig 1.). The preservation of lawsonite in three out of four mineral parageneses precludes extensive thermal overprinting in the greenschist facies.

Preliminary K/Ar dating of phengites was inconclusive with ages ranging from 16.5–32.8 Ma. In order to resolve this large scatter in ages, four samples were selected for $^{40}Ar/^{39}Ar$ analysis. We have used *c.* 5 mg samples using a laser incremental heating technique, operating the argon laserprobe with a defocussed beam to uniformly heat the 125–250μm mineral separates. Laser incremental heating analysis of these samples confirms the inhomogeneous radiogenic argon content of these samples. Integrated ages are 27.47 ± 0.74 Ma, 25.16 ± 0.46 Ma, 20.76 ± 0.48 Ma and 29.07 ± 0.54 Ma for SNE10, SNE11, SNE12 and SNE15, respectively. The age spectra of all four samples show consistent features: staircase patterns with ages as low as 20 Ma in the low temperature steps of the spectra increasing in all cases to plateaux of *c.* 35 Ma at the highest temperature steps (Fig. 2).

Thermobarometric data indicates that the phengites were formed at a temperature very near the closure temperature for the argon clock, and remained at such temperatures until decompression was quite advanced. There is no evidence

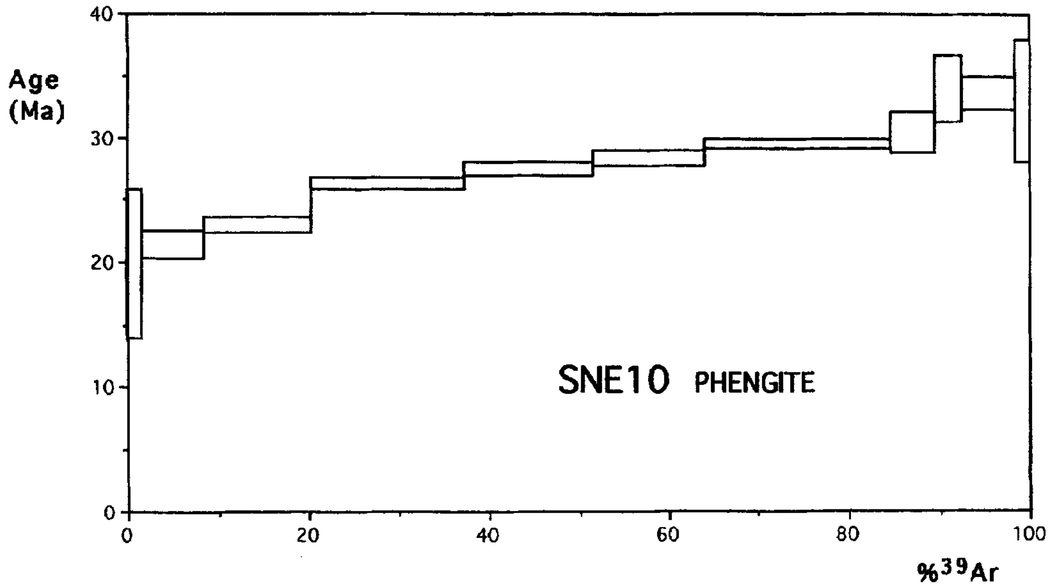

FIG. 2. Age spectrum of SNE10. The staircase release pattern is interpreted as recording continued partial loss since crystallisation at *c.* 35 Ma.

for substantial subsequent thermal overprinting. We argue that the radiogenic argon gradients in these phengites are the result of slow cooling during the decompression segment of the PT loop. Because the maximum temperatures during metamorphism have not exceeded the closure temprature for argon significantly, we argue that the plateau ages of all four samples record the time of crystallization of the phengites 35 Ma ago, and that slow cooling during uplift caused partial loss of radiogenic argon until the system finally reached upper crustal levels in the Late Miocene.