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SOME K/AR AGES FROM THE CHILAS COMPLEX IN SWAT

The stratiform Chilas complex extends for 300 km from Astor, through Indus Kohistan and Swat, to western Dir. It has a width of ~ 40 km in the middle part. The complex consists principally of norites with subordinate dunites, peridotites, pyroxenites, troctolites, gabbros, anorthosites, hypersthene-quartz diorites, and pyroxene pegmatites. These rocks have undergone at least two phases of metamorphism and deformation. The first phase of metamorphism occurred under pyroxene granulite facies at about 800°C and 5–7 kbar (Jan, 1977; Bard, 1983). Subsequently, during obduction, amphibolite- and greenschist facies assemblages were locally overprinted on these rocks, especially along shear zones.

The Chilas complex is the back-bone of the Kohistan island arc and an understanding of this complex is of vital importance to the tectonic and petrological evolution of the arc (Bard *et al.*, 1980; Jan, 1980). The complex represents a good example of the deep-seated (lower crustal) processes in island arcs and continental regions. Coward *et al.* (in press) suggest that the Chilas rocks may be cumulates in the magma chamber of the Kohistan volcanics. No satisfactory geochronological work has been carried out to suggest a precise age for the intrusion of the complex; speculations range from Precambrian to post-Eocene. In this note, four K/Ar dates (three of them new) from the Swat portion of the complex are briefly described. The ages fall between 64 and 79 m.y.b.p. and record uplift and cooling.

Speculations regarding the Age of the Chilas Complex. Wadia (1932) suggested that the norites and related rocks of the Chilas area were genetically related to the Permo-Carboniferous Panjal volcanics. Subsequently, Misch (1949) considered that the norites were synkinematically metamorphosed "during the Early Tertiary Main Himalayan Orogeny", not a very long time after the original norite bodies had formed. Jan (1970) speculated that the Indus valley norites were intruded during the earlier phases of the Himalayan orogeny (middle to late Cretaceous). A Creto-Eocene age was also suggested for these rocks by Desio (1974).

In Swat valley, the Hornblendic Group (including the amphibolites and norites of the Chilas complex) was thought to be Precambrian and thrust over the Paleozoic metasediments of the Lower Swat-Buner area (Martin *et al.*, 1962). However, Jan and Mian (1971) suggested a late Cretaceous age for these norites also. A K/Ar date of 67 Ma was reported for a hornblende from a pegmatite cutting norites near Bahrain (Jan and Kempe, 1973). Since the pegmatite was regarded to represent the last phases of the igneous and metamorphic activity, a Cretaceous age seemed plausible for the Chilas complex. An 84 m.y. U/Pb date on zircon from pyroxene granulite in Upper Swat (Zeitler *et al.*, 1980) lent further support to this idea. However, Chaudhry and Chaudhry (1974) suggested that the norites and other intrusive rocks around Khagram, Dir district, post-date the Eocene volcanics.

Impressed by the suggestion of Spooner and Fairbairn (1970) that all reliably dated pyroxene granulites are Precambrian, Jan (1977) also jumped to such a conclusion regarding the age of the Swat noritic granulites. More recently, however, Windley (1981) has presented several examples of Phanerozoic granulites, including those of the Chilas complx. As additional field and petrologic data gathered, it became apparent that the Chilas complex is an integral part of the Kohistan island arc sequence. Jan (1980) reconsidered his previous views and proposed that the complex formed during the embryonic stages of the Cretaceous arc.

The Chilas complex intrudes subduction-related island arc volcanics (now amphibolites) of late Jurassic to Cretaceous age. To the south of the Chilas complex, the volcanic rocks have

been converted into an extensive belt of amphibolites and a variety of other rocks. Further south along the MMT occur high-P garnet granulites of the Jijal complex. This complex may represent a folded limb or tectonic slice of the Chilas complex, or it may be a separate intrusion of the Chilas magma. The granulites of the Jijal complex have a Sm/Nd age of 103 m.y. (Coward *et al.*, in press). These have been derived from Chilas-like pyroxene granulites rather than directly from magmatic rocks (Jan, 1980; Bard, 1983). The pyroxene granulite facies metamorphism of the Chilas Complex, therefore, must be older than 103 m.y. (i.e., about 110 m.y.). For these reasons, Jan (1980), Jan and Asif (1983) and Bard (1983) suggested that the Chilas complex was emplaced during the earliest phases of development of the Kohistan Island arc, about 125 to 135 m.y. ago.

K/Ar Dates from Swat. K/Ar dates have been obtained on four samples from the Chilas complex in Swat Kohistan. The data are presented in Table 1.

TABLE 1. K/Ar DATES FROM CHILAS COMPLEX IN SWAT-KOHISTAN

Sample No.	Material	Age in m.y.	Description
SH 13	Hornblende	67	Pegmatite in norite, Bahrain (from Jan & Kempe, 1973).
SH 37	Whole rock	79	Hypersthene-hornblende-biotite-quartz diorite, 9¾ km S of Kalam.
SH 37	Hornblende	74	The rock is a granulite in which Hbl and Bio developed probably during retrogression.
US 14	Whole rock	64	Two pyroxene granulite near Biha, 17.5 km NW of Matta.

Samples 37 and 14 determined by C.C. Rundle, IGS London

Field studies and petrography suggest that hornblende in SH 37 grew secondarily at the expense of pyroxene mainly, whereas the pegmatite bodies have formed by metasomatic processes. The age of hornblende in SH 37 is younger than that of the whole rock but the two ages would not be significantly different at the 95% confidence level if the error in potassium determination were in fact 2%. Surprising is the younger age of the granulite (US 14) sample compared to others. It can be attributed to a number of factors such as argon loss from the non-retentive sites in the whole rock sample, to overprinting caused by a later tectonic, intrusive or magmatic activity.

It has been noted by a number of workers that K/Ar ages of rocks that have gone through polyphase metamorphism and deformation usually record younger periods than the actual age of formation (cf. Le Fort *et al.*, 1983). It seems that the four K/Ar determinations from Swat record cooling and uplift ages after the rocks had passed through pyroxene granulite facies metamorphism. Similar ages (70–80 m.y., according to Shams, 1980, and Maluski and Matte, 1983) were obtained on Shangla blueschists of the Indus suture zone. Hence Bard (1983) suggested that the high-P metamorphism may have taken place during obduction.

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