Precise U-Pb ages from the Kohistan Complex (Northern Pakistan) illustrate rapid formation of arc-type crust.

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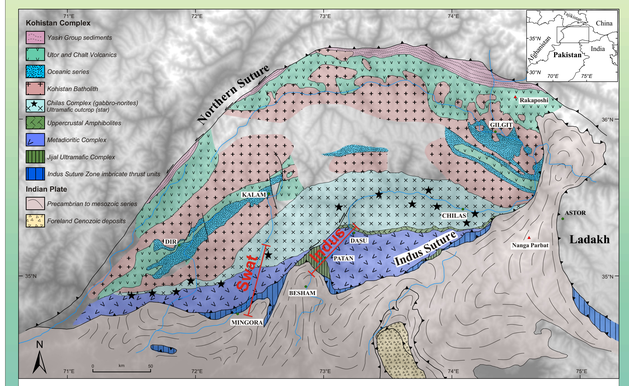
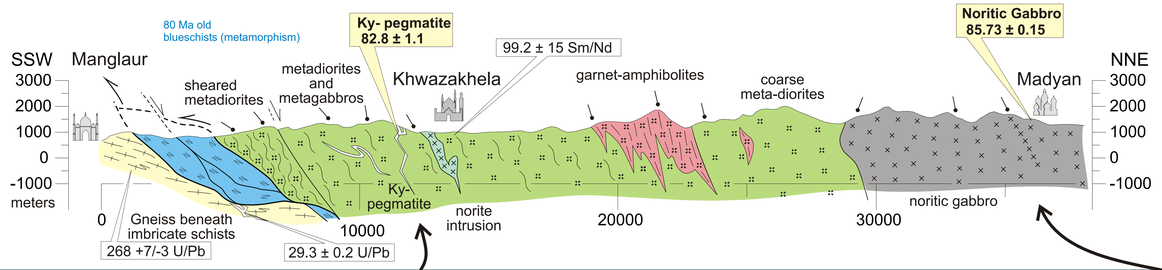


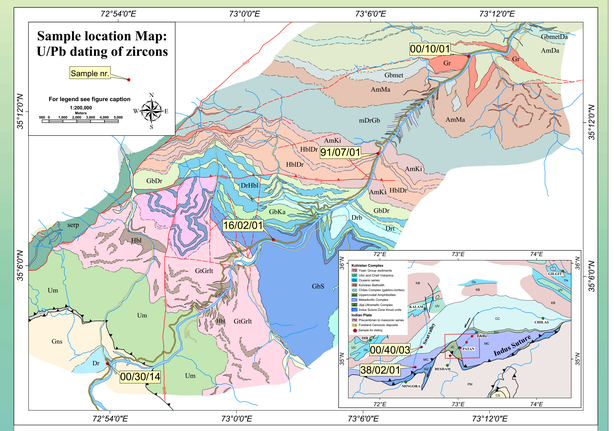
Geological map of the Kohistan Arc Complex
(after Bard *et al*. 1983; Burg *et al*. 1998).

The Kohistan Arc Complex separates the Indian and Asian plates in NW Pakistan and exposes mantle-crust transition, and mantle-derived magmatism (Bard *et al*., 1980). It was formed during Cretaceous north-vergent subduction in the Tethys ocean (Klootwijk *et al.*, 1979; Tahirkheli *et al.*, 1979).
The juvenile arc crust shows a syn-magmatic granulite-facies overprint but no younger HP metamorphism from deep subduction. Accretion to Asia and subsequent thrusting onto the northern margin of the Indian plate along the northward dipping Indus Suture Zone constitute the collisional history. TheKohistan Arc Complex was suggested to have formed during two major tectonic stages:
- an initial arc-building stage starting before 100 Ma and lasting to at least 90 Ma; and
- an extensional intra-arc rifting stage during which huge volumes of noritic gabbros were emplaced between 85 and 80 Ma.

It therefore provides opportunity to investigate melt sources over 20 million years' lifetime of an island arc.

Swat section with new and published (Anczkiewicz, 1998; Anczkiewicz and Vance, 2000) ages. A large intrusive body of calc-alkaline noritic gabbros, the Chilas complex, intruded into volcanic and sedimentary rocks in the central part of the arc. Kyanite-bearing pegmatoid dykes intruded into granulitic gabbros.

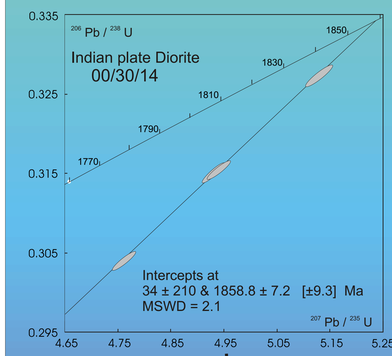


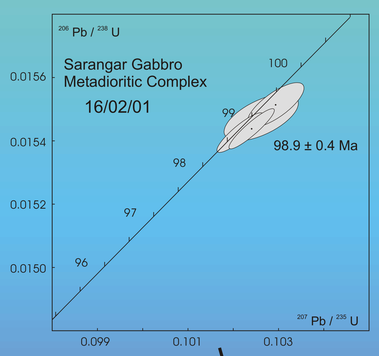


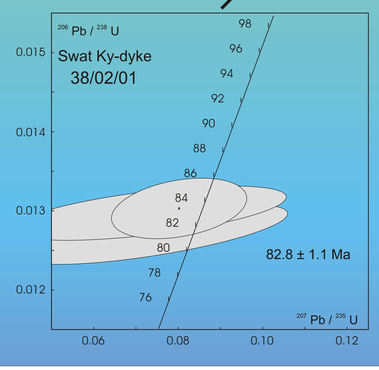
U/Pb-dating sample locations
Samples from Swat valley in the inset.
(Short Legend: Gns: Indian Plate Gneiss; Dr: Indian Plate Diorite; Um: Jijal Ultramafics; GtGrlt: Granulitic Gabbro; GbS: Sarangar Gabbro; HblDr: Hornblende Diorite; Gr: Granitic Rock; AmDa: Dasu Amphibolites)

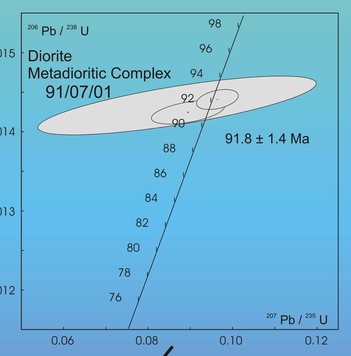
U/Pb-dating results

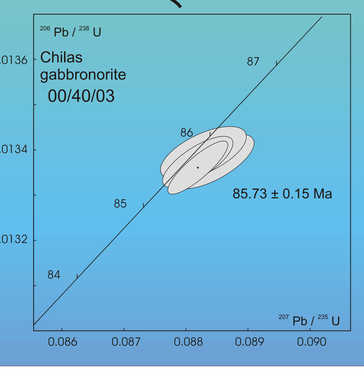
Zircons were air-abraded and washed in distilled aceton and water in an ultrasonic bath. Mean ages are given at the 95% confidence level.

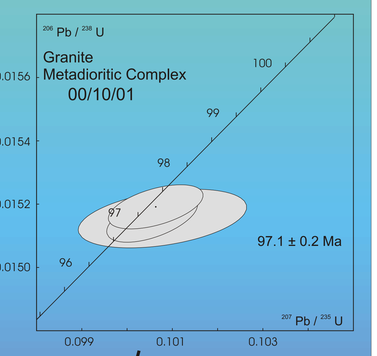


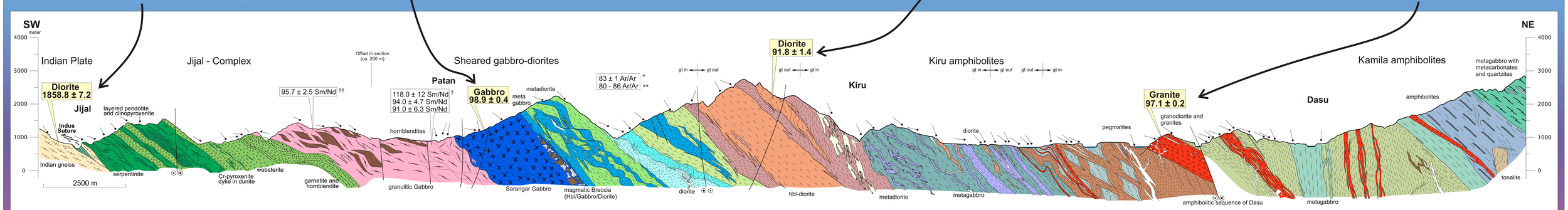




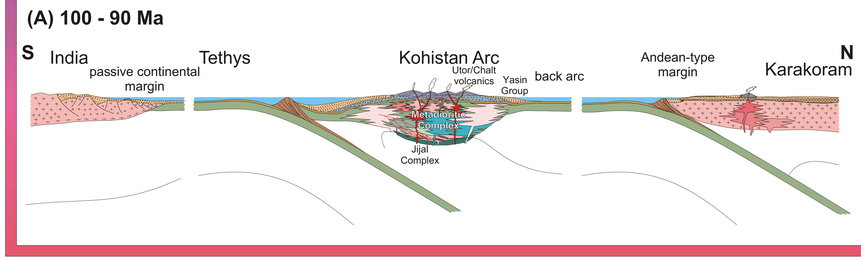


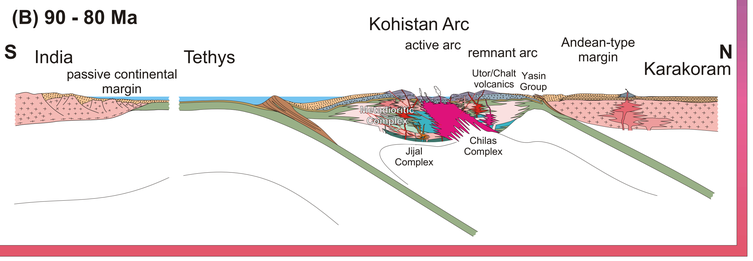






Indus section with new and published ages (*Treloar *et al.*, 1990; **Wartho *et al*., 1996; †Yamamoto and Nakamura, 2000; ††Anczkiewicz and Vance, 2000).



Interpretation:

Age determinations suggest a two-stage model for the Kohistan Complex: (A) initial arc-building started pre-100 Ma and lasted to at least 90 Ma, with the emplacement of gabbroic to granodioritic melts; and (B) the extensional intra-arc rifting stage at ca. 85 Ma, characterized by the emplacement of gabbronorites. Subsequently felsic dykes intruded under high-pressure conditions, most likely by injection of small volumes of granitic melts generated by anatexis at the base of the arc. Despite the continuous nature of subduction and melt generation we anticipate magmatism to happen in multiple, short-lived differentiation events. The results demonstrate that the rate of magmatic differentiation in an arc environment are very fast and can produce juvenile melts of granitic composition with depleted mantle isotopic characteristics within 2 million years. The studied granite and felsic dyke are part of the arc magmatism and are not derived from post-obduction melting of crustal sources.