Geochemistry and clay mineral assemblages of pre- to post-orogenic coarse clastics of the eastern Afghan-Tajik depression (Central Asia)

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The Afghan-Tajik basin fill is up to 10 km thick and spans from the latest Triassic to Quaternary. Three consecutive stages of basin development are recorded, corresponding to pre-, syn- and post-orogenic stages of the Pamir and Tian Shan: a) continental sag basin (Jurassic to Paleogene), b) foreland basin (Neogene) and c) fold-and-thrust belt (late Miocene to recent).

To investigate the impact of orographic barriers on Central Asian climate circulations and weathering, an almost continuous section from the late Cretaceous to Pliocene, roughly 5 km in thickness, from the eastern margins of the Afghan-Tajik depression has been studied, particularly in terms of lithofacies analysis, sedimentary architecture, whole rock geochemistry and clay mineral assemblages. Uplift and erosion of the Pamir from the early Miocene on is recorded by formation and pronounced progradation of larger alluvial fan systems. Throughout the Miocene, alluvial fans are more or less successively transformed to fluvial mega fans. The mass-flow-dominated alluvial fan successions are characterised by monotonous amalgamated conglomerate units of several decametre thickness with up to 3 m large boulders, disorganised matrix supported structure and up to 40-60 % of a shaly matrix. In contrast, fluvial mega fan successions are characterised by stacked and amalgamated beds of up to 5 m thickness forming up to some decametre thick monotonous units of clast supported and organised conglomerates with well rounded and elongated clasts. The content of a sandy matrix decreases down to 30 to 40 %. The transformation of alluvial fans to fluvial mega fans evidences the change from ephemeral to more continuous sediment transport, that may result from increased discharge.

More than 200 siltstone samples have been collected throughout the section for geochemical and clay mineralogical analyses, to discern the weathering processes and hence the climatic evolution from early to late Miocene. The Chemical Index of Alteration (CIA) [1], Plagioclase Index of Alteration (PIA) [2] and Chemical Proxy of Alteration (CPA) [3] show an overall decreasing trend in chemical weathering from the early to middle Miocene (CIA 71 to 62) and a temporary excursion of increasing chemical weathering in late Miocene to early Pliocene (CIA 74). Contrarily, the clay mineral assemblages reflect an overall increasing trend in chemical weathering from the early to middle Miocene, indicated by strong increase of smectite (0 to 60%) and decreasing illite (95 to 20%). In late Miocene, chemical weathering subordinately decreases, indicated by dropping smectite values (30%).

The overall weathering trend, using the potassium/aluminium ratio (K/Al) points generally towards increasing chemical weathering from early to late Miocene, reflecting the assumed increased discharge, indicated by facies analysis and clay mineral assemblages, which may be due to changing trans-regional circulation patterns.

[1] H.W. Nesbitt and G.M. Young, Early Proterozoic climates and plate motions inferred from major element chemistry of lutites, Nature v. 299 (1982) p. 715 – 717.
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