Timing of shallow level emplacement of the Sillai Patti carbonatite complex, North-West Pakistan: Constraints from fission-track dating of apatite using the absolute approach

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The Sillai Patti carbonatite complex is located about 20 km west of Malakand, near Sillai Patti village. It is the second largest carbonatite complex of the Peshawar Plain Alkaline Igneous Province of northern Pakistan; the first one being the Loe-Shilman complex. At Sillai Patti the carbonatite occurs in the form of a sheet striking in the NNE-SSW direction and dipping southwards. The carbonatite body is about 12 km long and 2-20 m thick, and has been predominantly intruded along the faulted contact of metasediments and granite gneiss but locally within the metasediments.

Conduction of fission-track dating studies on the apatite crystals using the external detector method and absolute approach yielded an average fission-track age of 29.15 ± 0.91 Ma and a pooled fission-track age of 29.10 ± 1.02 Ma for the Sillai Patti carbonatite of Malakand area. These ages are concordant with the K-Ar age of 31 ± 2 Ma on biotite and fission-track age of 32.1 ± 1.9 Ma on zircon from the same carbonatite body. This concordance of apatite fission track (AFT), zircon fission track (ZFT) and K-Ar biotite ages, therefore, robustly suggests that they all document the age of emplacement of the Sillai Patti carbonatite complex. Age concordance, the porphyritic textures of the carbonatites and apatite fission track modeling, all indicate rapid cooling from emplacement temperatures.

The fission track ages on apatite from the Sillai Patti area are also concordant with the $^{206}Pb/^{238}U$ age of 29.26 ± 0.12 Ma on zircon and Ar-Ar age of 28.4 ± 1.1 Ma on muscovite from the alkaline granitic dyke of Lower Swat area, K-Ar age of 31 ± 2 Ma on biotite from the Loe-Shilman carbonatite, fission track age of 29.3 ± 1.2 Ma on apatite from the Jambil carbonatite of Lower Swat area and fission-track age of 30.0 ± 1.5 Ma on apatite from the Loe-Shilman carbonatite. The strong resemblance of the fission-track apatite age of this study with the fission-track as well as other high temperature radiometric ages from the other localities of the alkaline belt of northern Pakistan also strongly documents that the Sillai Patti carbonatite complex was emplaced at high crustal level (shallow burial depths) and cooled there relatively rapidly to near surface temperatures.