Goldschmidt 2000
September 3rd–8th, 2000
Oxford, UK.

Journal of Conference Abstracts
Volume 5(2), 346

Combination of Zircon Morphology and Fission Track Dating in Provenance Studies – Origin of the Macigno Formation (Apennines, Italy)

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Fission track (FT) analyses on unannealed clastic minerals provide a powerful tool both for refining provenance pictures derived from traditional methods and for collecting information about the source area uplift rate; their power is largely increased if they are coupled with other provenance approaches on minerals retaining fission tracks, such as the study of zircon morphology. Such approach is applied to the Chattian-Aquitanian Macigno turbidite complex, by crossing zircon FT and morphology analyses with available data from sandstone petrology and basin fill pattern. From a provenance viewpoint, both basin-fill pattern and petrographic studies consistently identify the uplifting Western-Central Alps, as the main source of the Macigno complex; these data were interpreted as the result of the rapid uplift of a lithospheric block.

The most of zircon grains fall in a young age cluster (~40-30Ma) reflecting an actively exhuming crystalline source region with high cooling rate; within this cluster, two age subgroups can be distinguished, around 30 and 40Ma respectively. In the youngest subgroup, zircon morphology supports the presence of two main populations: one fed by magmatic rocks (S-type euhedral zircons), possibly partly having a volcanic air transport; another sourced by metasedimentary units. The source was the metamorphic rocks from the zone of the Periadriatic intrusives, where the extreme high geothermal gradient reset the thermo-chronometers in huge crustal volumes in Middle Oligocene time. On the recently exposed surface of the Alps, zircon FT ages around and slightly below 30Ma are reported in the Sesia-Lanzo zone, Gran Paradiso Massif, Upper Pennine nappes, Monte Rosa Massif and Dent Blanche complex. The older subgroup of the Tertiary zircons (40Ma subgroup) can also have an igneous origin, but it could also be fed, possibly, by metamorphic and migmatitic rocks affected by the Eocene high temperature phase.

The second age cluster is Late Cretaceous s.l. (~70-60Ma), i.e. related to the cooling period after the main Austroalpine metamorphic event, whose climax was around 110-100 Ma ago, the mica cooling ages are around 95-70Ma and the zircon FT ages range between 99 and 55Ma in the most of the Austroalpine nappe complex.

At last, a very loose Jurassic cluster, with a mean in the Late Jurassic time, is detected; it can be related to the thermal effect of the Penninic rifting on the Austroalpine-Southalpine crystalline basement, which underwent a rift-shoulder heating. Nowadays, the Silvretta nappe complex, situated at the western termination of the Austroalpine realm, as well as Southalpine basement westward from the Canavese Line contains similar zircon FT ages; therefore, the western continuation of the Silvretta complex before the deep Neogene erosion is suggested, possibly coupled with the funnelling in the Macigno basin of the erosion products of the western Southalpine basement.

These data reflect a Macigno source located on an actively exhuming crystalline region with high cooling rates, including the exhumed lid of the "fastly cooling" Western Alps orogen, with a contribution from the Periadriatic intrusives and their volcanic products.