# The Peruvian coastal margin,

# Evidence from low-temperature Thermochronology

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Western Peru including the Western Cordillera and the coastal margin is made up mainly of the Coastal Batholith and the Precambrian to Palaeozoic Arequipa Massif. The Coastal Batholith of Peru consists of over one thousand different plutons ranging in age from Upper Jurassic to Upper Cretaceous and from Eocene to early Miocene (Pitcher, 1985). It forms a complex but well defined linear feature which follows nearly the entire Peruvian coast, extending through isolated plutons into Ecuador and Chile. The granitoidic petrology of the individual intrusive bodies shows only minor variations. The climatic zone runs parallel to the Andes and therefore almost the entire coastal region is subject to the same very dry climate. Hence many parameters that might have an effect on erosion rates such as variations in climate and in rock type are tightly constrained and uniform within the whole area. This makes Western Peru an exquisite region to study the evolution of a coastal margin in an area of active subduction. Additionally the Nazca Ridge located on the oceanic Nazca Plate is being subducted in an essentially east-west direction underneath the South American Plate. There is a clear trend towards a south east passage of the collision zone over the last 10-12 Myrs (Hampel, 2002; Pilger, 1981). The Peruvian coastal margin therefore offers unique possibilities to study the interaction of the different processes involved.

The tools best suited to constrain the evolution of the Peruvian coastal margin and the Western Cordillera as well as the processes induced by the Nazca Ridge are low temperature geochronometers such as fission-track and (U-Th)/He. Samples collected at several locations in the Western Cordillera and the Peruvian Coastal margin between Piura (Lat. 5°30S) and Tacna (Lat. 18°S) at altitudes from sea level to 3500 m have been analyzed. Cooling histories determined through modelling of the fission track data show two distinctly different types of cooling histories.

a.) Rocks from Precambrian or Palaeozoic suites show simple slow cooling. Significant changes in the rate of cooling within these models can be correlated with known major tectonic events like the Peruvian- and the Incaic Phase. In the models from central and northern Peru only the Incaic event is observed. This implies that the older Peruvian phase was weak or absent in these areas. The models from the very south show a change in cooling which can be correlated with the Peruvian Phase. There is no indication of an event which can be associated with the Incaic Phase.

b.) The modelled cooling histories from the Coastal Batholith show a phase of very rapid cooling just after intrusion which was as high as 60°C/Ma. This cooling slows down and eventually becomes indistinguishable from the slow cooling observed in the Precambrian and Palaeozoic rocks. In most models a significant slow down of the cooling rate is observed at various times. These changes are thought to represent the adjustment of the high geothermal gradient of the intrusives to the surrounding gradient of the "old" crust and are not believed to represent tectonic events. In the majority of the models a relatively long period of quiescence with slow continuous exhumation follows. Depending on the variable age of the intrusions and the rates of cooling, the duration of the subsequent period of quiescence varies.

A renewed increase in cooling rates is observed between 8-1 Ma in various samples at altitudes between 95 and 2895 m. In most cases these changes are outside the APAZ (Apatite Partial Anealing Zone) and therefore inconclusive. In samples from central Peru however this renewed phases of rapid exhumation are supported by He data. It is plausible that the event seen is real as the Cordillera Blanca located east of these sites began uplifting at ~6 Ma.

In general the He ages of fast cooled samples like the Coastal Batholith tend to reproduce nicely and support the modelling of cooling histories based on fission-track data. Apatite He ages from the slowly cooled Precambrian and Palaeozoic suites with potentially complex cooling histories and extensive periods spent within the HePRZ produce a huge scatter of ages.

An impact caused by the subduction of the Nazca Ridge is seen in the change of apparent apatite fission track- and He-ages occurring over today's position of the ridge. The younger ages in the north are the result of enhanced erosion due to surface uplift caused by the passing of the ridge. The very young He ages determined in the vicinity of the knickpoints in the Lunahuana and the Pisco valley are interpreted to be the result of enhanced river incision. Data for a possible late Neogene tectonic event recorded by the modelled cooling histories of central Peru is difficult to interpret. A correlation with the passing of the Nazca Ridge is plausible but extremely difficult verify.

In conclusion it can be said that no significant erosion has been taking place in the entire coastal margin. The modelled cooling histories are in good agreement with notions that the area has been dry since at least 23 Ma possibly 37 Ma (Dunai et al., 2005) or maybe even since the Jurassic as proposed by (Hartley, 2005). An increase in erosion has occurred in the coastal areas uplifted by the subducting Nazca Ridge. This increase is relatively small however and has lead to younger apparent apatite fission-track- and He-ages. It is however not big enough to reveal the timing of the ridge induced uplift itself. At higher altitudes the enhanced erosion was big enough to expose very young He ages.

## References


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