Forearc deformation of the Peruvian margin: Quantifying the rates of Quaternary deformation in pediment surfaces using *in situ*-produced cosmogenic ^{10}Be and ^{26}Al

Sarah R. Hall [1], Daniel L. Farber [1,2], Laurence Audin [3], & Anne-Sophie Mériaux [2]

[1] University of California Santa Cruz, Dept. of Earth Sciences, Santa Cruz, CA 95064, USA
[2] Lawrence Livermore National Laboratory, Livermore, California 94550, USA
[3] IRD-LMTG, 14 avenue Edouard Belin, 31400 Toulouse, France

While the classical concept of an Andean style continental margin is commonly used in the geological literature to describe orogenesis in oceanic – continental collision zones, the quantification of the driving forces and the structures that accommodate the uplift of the Andean Cordillera remains an enigmatic and outstanding scientific issue. In this setting, the overall driving force for the deformation is derived from coupling between the subducting oceanic and overriding continental plate. Furthermore, temporal changes in the subduction angle may have profoundly modified both the degree of coupling as well as the strength of the South American lithosphere. However, detailing the tectonic effects of these changes in subduction style is difficult to quantify. The modern along-strike variations of subduction style along the South American margin can provide a natural laboratory for studying the effects of differing subduction geometries. In particular, two end-model geometries are clearly expressed along the Peruvian margin where flat subduction affects northern Peru, while southern Peru is characterized by more normal subduction angles. The transition region between these two end members lies at about 14°S near the Pisco deflection. Recent studies have highlighted active deformation, specifically extension, related to uplift in the forearc of this region (Audin et al, 2003, Hartley et al., 2000, Husson and Sempere, 2003) but have not quantified the rates or timing of this deformation. Fortunately, along this portion of the Peruvian margin there exist, well-preserved sequences of old pediment surfaces and marine terraces that form a unique set of datable markers that can be used to quantify the rates of Quaternary coastal uplift associated with the subduction of the Nazca plate beneath the South American plate.

The forearc of southern Peru, between ~14.5°S-18°S, consists of a longitudinal depression, the Llanuaras Costanera, also called the Moquegua Basin, bound by the Cordillera de la Costa in the west and the Precordillera and main Cordillera Occidental to the east. Fan deposits of the Moquegua Formation, which are the focus of this study, have ages ranging from 30 to 3 Ma (Tosdal et al., 1984). These fans are well-preserved and cover vast areas of up to 5 km^2. Along these pediment surfaces, abrupt changes in topography, visible changes in drainage incision, and the offset of alluvial terraces indicate recent uplift and/or faulting. Our goal is to use cosmogenic ^{10}Be and ^{26}Al to calculate the surface exposure ages of these offset surfaces to derive slip rates and the rates of regional deformation. Initial cosmogenic ages of two main surfaces at Palpa (~14.6°S, 75.1°W) yield ages of ~180 ± 28 ka and 1 ± 0.2 Ma. These old cosmogenic ages not only suggest an extremely low erosion rate but point to the extended history of deposition and incision that is tractable in this region.

Near Mirave (17.4°S, 70.8°S), Tosdal et al. (1984) mapped and dated the formation of pediment surfaces using K-Ar isotopic ages of imbedded ignimbrites to 8.5-14.5 Ma. Using cosmogenic dating we have obtained average ^{10}Be ages of 267 ± 48 ka and 265 ± 48 ka on two separate pediment surfaces. Our cosmogenic ages are much younger than those published by Tosdal et al. for similar surfaces and therefore suggest a significantly younger

morphology that can be used to quantify Quaternary uplift and deformation. Detailed mapping and cosmogenic dating on other sites in this area is currently in progress and can be used to establish slip/uplift rates for the region.

The surface exposure ages from Palpa and Mirave provide a small glimpse of the possibility of correlating kilometer scale pediment surfaces for long distances along the forearc of Peru. The evaluation of the regional scale effects of changing subduction geometry on uplift rates and deformation characteristics in the forearc region can thus be quantified by the correlation of these pediment surfaces (and marine terraces). Our work in dating offset terraces along active faults is beginning to show a new Quaternary chronology illustrating the age and uplift rate variations along the strike of the Peruvian margin and suggesting a much more active tectonic setting that previously thought. This unique data set will provide new constraints on the currently proposed hypotheses for active deformation of the Andean forearc, and for the latitudinal changes in tectonic forcing due to changes the in the style of subduction, along the South American margin.

References

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