SEDIMENTARY AND STRUCTURAL EVOLUTION OF THE EOCENE-OLIGOCENE CAPAS ROJAS BASIN: EVIDENCE FOR A LATE EOCENE LITHOSPHERIC DELAMINATION EVENT IN THE SOUTHERN PERUVIAN ALTIPLANO

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The Eocene-lower Oligocene Capas Rojas basin of the Cusco area is located at the northern end of the Altiplano. An important uplift of northern edge of the Western Cordillera around the Eocene-Oligocene boundary is documented by the evolution of the large Eocene-Oligocene Andahuaylas-Yauri batholith (Carlier et al., 1996).

Two sub-basins are recognised: the distal San Jerónimo sub-basin and the proximal Anta sub-basin (Fig. 1). Both sub-basins are separated by an important NNW-SSE strike-slip fault system (Accha-Huanoquite-Ccorca, Cusco-Sicuani, Sicuani-Ayaviri, and Lagunillas-Mañazo faults) that presumably controlled their evolution (Carlotto, 1998).

THE DISTAL SAN JERÓNIMO SUB-BASIN

The red beds deposited in the San Jerónimo basin unconformably overlie Paleocene and Eocene units (Jaillard et al., 1994). Near the top of the Capas Rojas (Fig. 2), a trachytic tuff is dated 29.9 ± 1.4 Ma (Carlotto et al., 1995; Carlier et al., 1996). The San Jerónimo red beds are thus Eocene and early Oligocene.

In the Cusco area, the San Jerónimo red bedsconsist of two thick formations: the K'ayra Formation (~3000 m) and the overlying Soncco Formation (~2000 m). Both are made up of silts, sandstones and conglomeratic sandstones of fluvial origin. Each consists of a coarsening-upward sequence that represents progradation of a fluvial system. Paleocurrents are directed toward the north in the K'ayra Formation and toward the northwest in the Soncco Formation. The finer upper part of the Soncco Formation indicates a significant change in the regional tectonic regime.

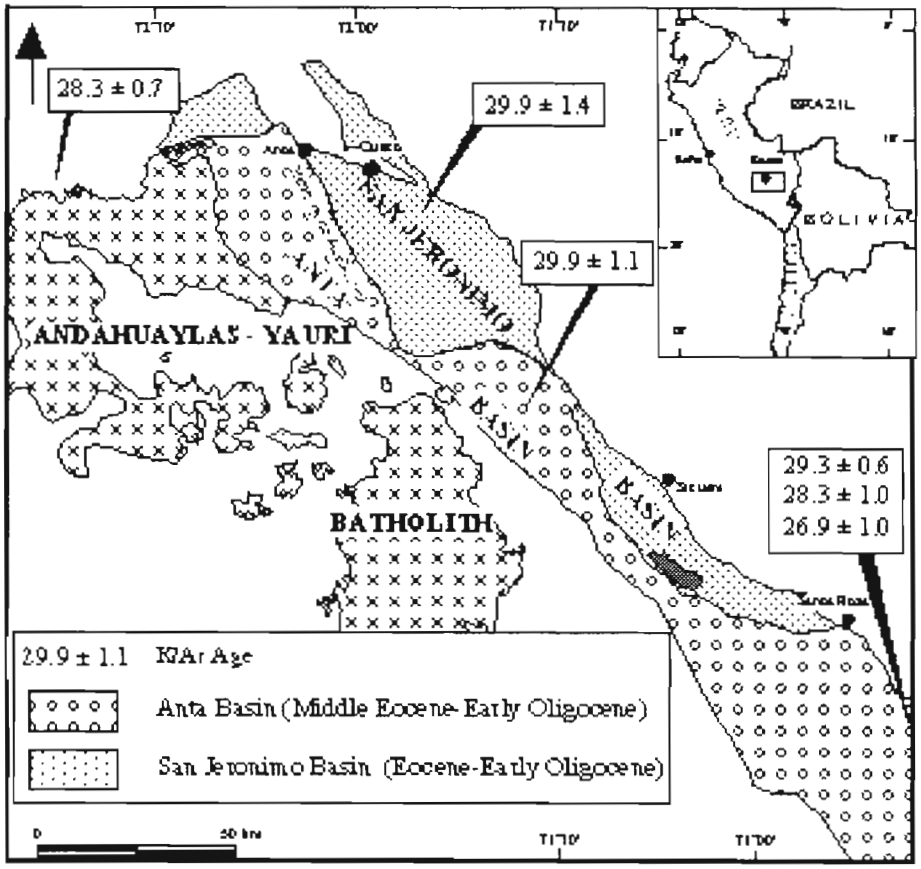

Fig. 1.- Structural sketch-map of the Cusco region,
showing the Anta (proximal) and San Jeronimo (distal) basins

THE PROXIMAL ANTA SUB-BASIN

The red beds of the Anta sub-basin unconformably overlie Cretaceous-Paleocene strata and Eocene intrusive rocks of the Andahuaylas-Yauri batholith (Carlotto, 1998). The lower and middle parts of the Anta red beds are thick (1500 m) and composed of conglomerates, breccias and sandstones (Fig. 2). These deposits are organized in coarsening-upward sequences interpreted to represent the superposition of syntectonic alluvial fans. The upper part of the Anta red beds (400m) comprises fluvial sandstones and mudstones associated with rare lacustrine limestones (Fig. 2). These deposits indicate a significant change of the regional tectonic conditions.

Calco-alkaline andesite and dacite flows intercalated in the middle Anta Formation are dated 38.4 ± 1.5 and 37.9 ± 1.4 Ma (Carlotto, 1998). The upper Anta Formation contains trachybasaltic flows dated 29.9 ± 1.1 Ma (Carlier et al., 1996; Carlotto, 1998). This magmatic activity implies that the red beds of the Anta basin were deposited during the late Eocene and early Oligocene. Consequently, the Anta Formation appears to be coeval with deposits in the San Jerónimo basin.

MAGMATISM

The trachybasaltic (46 wt% < SiO_2< 47 wt%; 5.6 wt% < K_2O+Na_2O < 5.7 wt%, 0.8 < K_2O/Na_2O < 0.9) and trachytic (SiO_2= 60.8 wt%; K_2O+Na_2O = 10 wt%; K_2O/Na_2O = 0.3) rocks intercalated in the upper part of the Anta and Soncco formations belong to alkaline series (Carlier et al., 1996). They are strongly enriched in LILE (Ba = 820-1750 ppm, Rb = 68-70 ppm), Sr = 1040-1110 ppm, La = 14.1-17.7 ppm) and depleted in HFSE (Nb = 6-7 ppm) and display low LILE/LREE ratios (Sr/Nd = 46-54, Ba/La = 48-124). In spite of their general depletion in HFSE, these rocks show low LILE/HFSE ratios (La/Nb = 2.4-2.5; Th/Nb = 0.3-1.0). Such geochemical characteristics are considered to reflect the composition of the subcontinental lithospheric mantle from which they originated (Kay et al., 1994; Comin-Chiaramonti et al., 1997).

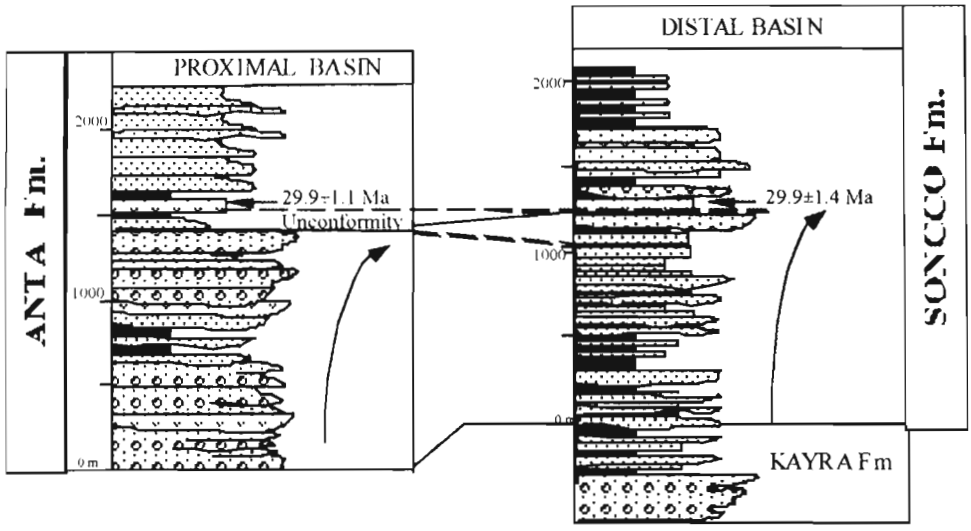

Fig. 2.- Stratigraphic columns of the Anta (proximal) and Soncco (distal) formations

UPLIFT AND TECTONIC

Calc-alkaline gabbroic cumulates form the main part of the northern rim of the Andahuaylas-Yauri batholith and are dated between 48 and 42 Ma (Carlier et al., 1996). They are intruded by granodioritic and dioritic subvolcanic stocks dated between 38 and 32 Ma (Carlier et al., 1996). These relationships document that a significant and rapid uplift (at least 5000 m) occurred along the northern rim of the Western Cordillera during the late Eocene and early Oligocene. The major shortening (up to 70%) documented at the Western Cordillera / Altiplano boundary is associated with this uplift (Carlotto, 1998). Erosion of reliefs produced by this uplift provided detritic material which filled the proximal Anta and distal San Jeronimo sub-basins. Deposition of the coarsening-upward Anta and Soncco formations was thus coeval with the compressional uplift of their source areas. In the upper Anta Formation (proximal sub-basin), thick alluvial fan deposits are overlain by strata of fluvial-lacustrine origin that include a trachybasaltic flow dated 29.9 Ma. In the Soncco Formation (distal sub-basin), a trachytic tuff also dated 29.9 Ma is associated with the sudden appearance of alluvial conglomerates in the succession.

DISCUSSION AND CONCLUSIONS

Rapid regional uplift and extension, accompanied by lithospheric thinning and increased magma production, have been recently recognised to indicate lithospheric delamination, i.e. rapid sinking of a lower lithosphere fragment into the asthenosphere (Bird, 1979; Kay et al., 1994). In the Cusco area, along the northern edge of the Western Cordillera, a significant late Eocene and early Oligocene thermal event

is documented by the existence of the Andahuaylas-Yauri batholith, which strongly suggests that advection of hotter asthenospheric mantle into shallow depths occurred in this area. The significant shortening associated with this thermal event also resulted in rapid uplift of the northern rim of the Western Cordillera. Erosion of this uplifted area generated the proximal coarse and distal fine deposits observed in the lower part of the Anta and Soncco formations, respectively. The upper part of each unit records an abrupt change in sedimentation, which is associated with a short middle Oligocene alkaline magmatic event: in the proximal Anta sub-basin, fine-grained strata abruptly overlie coarse-grained deposits; in the distal San Jeronimo sub-basin, alluvial conglomerates abruptly overlie fine-grained deposits. This sedimentary event is interpreted to reflect an isostatic rebound due to a change in the regional stress regime (see i. e., Heller et al., 1988). The coeval occurrence of alkaline suites demonstrates that the lithospheric mantle was involved in this process.

The abrupt changes in sedimentation recorded in the upper Anta and Soncco formations are reminiscent of a delamination process (Kay et al., 1994). As the Cusco area underwent rapid regional uplift and subsequent relative tectonic quiescence during the late Eocene - early Oligocene interval, we propose that a delamination process occurred in this area in the late Eocene. The characteristics of the coeval magmatic activity are in agreement with this hypothesis.

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