TECTONIC EVOLUTION OF THE CENTRAL ANDES SINCE THE CRETACEOUS

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RESUMEN

Los Andes Centrales de Bolivia y Norte de Chile forman parte de un límite de placas entre Sudamérica continental y la placa subductante de Nazca. Desde el Cretácico, esta región ha sido solevantada hasta formar la parte más ancha de los Andes. La deformación ha sido contínua durante este período, aunque su localización ha cambiado marcadamente. Se incluye un esquema de la evolución terciaria de los Andes de Bolivia, basada en un estudio de las secuencias sedimentarias cretácicas y terciarias, y en datos paleomagnéticos

KEY WORDS: Central Andes, tectonic evolution, palaeomagnetism.

INTRODUCTION

The Central Andes of Bolivia and northern Chile form part of the plate-boundary zone between the continental South American and subducting oceanic Nazca plates. Since the Cretaceous, this region has been uplifted to form the widest part of the Andes, reaching an average elevation of ca. 4000m in a region 700 km wide. Though deformation has occurred throughout this period, its locus has changed markedly. The following description briefly outlines the Cretaceous and Tertiary evolution of the Bolivian Andes, based on extensive field work, K-Ar dating (Kennan et al. in preparation) and palaeomagnetic studies, as well as information from unpublished oil company reports and seismic sections. The Central Andes is viewed as a continuously growing mountain belt, rather than the product of discrete tectonic events.

PRE-CRETACEOUS AND CRETACEOUS DEFORMATION

There is a marked angular unconformity at the base of the Cretaceous. Open to tight folding, with limb dips up to 50°, a weak axial planar cleavage and extensive quartz veining are found in Palaeozoic flysch deposits beneath the Cretaceous throughout the Cordillera Oriental which are truncated by basal

EARLY TERTIARY DEFORMATION

Cretaceous sandstones, often containing fossilised dinosaur tracks, pass conformably into thick red-bed sequences. For instance, in the Camargo area of southern Bolivia, this transition can be traced along strike for over a hundred kilometres and is perfectly conformable. The basal part of the red-bed sequence consists of red siltstones with thin medium sandstone interbeds. However, within 150 m stratigraphically of the base of the sequence, conglomerates and thick coarse sandstones are well developed.

In both the Altiplano region and Cordillera Oriental, the basal few hundred metres of the Tertiary red-bed sequence shows a large dispersion in sediment transport directions, but then these become essentially unidirectional further up the sequence. This is interpreted as a transition from a highly meandering fluvial environment in a region of low topographic gradient, to a more uniform flow regime down a steeper gradient, representing the onset of deformation in this part of the Andes in the earliest Tertiary.

The uplifting regions can be defined with some precision from the pattern of sediment transport directions. The centre of the Cretaceous basin was inverted, so that the deepest part formed a narrow uplifting region in the earliest Tertiary, which shed sediment both to the east and west. This proto-cordillera

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developed as a narrow isolated range in what is today the western part of the Cordillera Oriental, separated from the active arc by a region several hundred kilometres wide. The intervening region formed a large intermontane basin which is now preserved in the Altiplano region of the Bolivian Andes, where up to 5 km of Early Tertiary continental sediments were deposited.

MIDDLE AND LATE TERTIARY DEFORMATION

Underformed Early Miocene ignimbrites show that north of the latitude 22°S, significant shortening deformation in northern Chile ceased in the Middle Tertiary. Deposition also continued in the Altiplano basin to the east, which received sediment both from the west and east. The distribution of Oligo-Miocene sedimentary sequences in the Bolivian Cordillera Oriental show that many local structural basins formed at this time, which locally sit with angular unconformity on older sequences. Shortening here also extended much further east than in the Early Tertiary. However, the nature of the eastern front of the Andes is not understood, but there is no evidence for a region of intense Middle Tertiary shortening similar to the

In the north, the Bolivian Andes is characterised by small anticlockwise rotations between 0 and 10°, observed in Cretaceous to Late Miocene sediments and volcanics, right across the width of the Andes. Further south, a zone can be defined, also extending right across the Andes, in which clockwise rotations between 0 and 10° are typical, observed in Cretaceous to Early Miocene sediments. And even further south, there is a zone, which again extends right across the width of the Andes, characterised by clockwise rotations between 20° and 30°, observed in Cretaceous to Late Miocene sediments and volcanics. These three principal zones can be ascribed to along strike gradients in the shortening in the Subandean zone, which has resulted in 'bending' of almost the entire width of the Central Andes since the Late Miocene.