

# COMPOSITIONAL TREND OF SANDSTONES AS AN INDICATOR OF FORELAND BASIN TECTONIC SETTING: AN EXAMPLE FROM THE UPPER DEVONIAN AND CARBONIFEROUS OF THE ALTIPLANO OF BOLIVIA (CENTRAL ANDES, 15-18°S)

DÍAZ-MARTÍNEZ, E.

ORSTOM, C.P. 4875, Santa Cruz, Bolivia

The compositional trend of clastic deposits can be used to address paleogeographic and paleotectonic questions. Where older orogenic belts have been deeply eroded, the sediment shed into the nearby basins records the evolution of the source area. However, modifying factors affecting detrital modes before and after sediment deposition must be taken into account, and their relative importance assessed, before a final statement on the paleotectonic setting can be made. Because sediment dispersal can connect different sources, and weathering, transport and diagenesis can have a crucial effect on sandstone composition, an adequate evaluation of other geologic sources of evidence in the region must also be pursued.

The Central Andes constitute part of the western margin of the former Gondwana supercontinent. The Paleozoic history of this margin is but a reduced aspect of the protracted evolution of a continental margin which has remained active for more than 1000 Ma, even before the formation of Gondwana, and after its rupture, until present time. Provenance analysis of Upper Devonian and Carboniferous sandstones in the Altiplano of Bolivia has been used in conjunction with other sedimentary evidence and regional paleogeographic features to identify a foreland basin tectonic setting related with the development of a marginal arc and associated retroarc foreland thrust-belt along the western margin of Gondwana during the Middle and Late Paleozoic. Upper Devonian and Carboniferous sedimentary rocks in the Bolivian Altiplano constitute a complex sequence of shallow clastic shelf, deltaic, coastal and carbonate ramp deposits interrupted by a Mid-Carboniferous disconformity of regional character. Sandstones in the Upper Devonian (Frasnian-Famennian) Colpacucho and Cuman Formations present quartzose and quartzolithic petrofacies, indicative of deeply weathered cratonic landmasses and/or recycled sediments from uplifted strata of fold-thrust belts. QpLvLs plots also indicate a provenance from collision suture and/or fold-thrust belt. Support for the latter interpretation is provided by Middle Paleozoic subduction-related magmatism to the west of the study area, NW-SE to N-S trending proximal-distal relationships parallel to an inferred active margin, and synsedimentary slumps and slides indicating tectonic instability and local paleoslopes dipping to the east. Isopachs of Upper Devonian deposits display similar trends, but palinspastic reconstructions have yet to provide a better view of the geometry of the basin, nowadays highly telescoped due to Cenozoic Andean deformation.

Sandstones in the Lower Carboniferous (Tournaisian-Visean) Kasa Formation present arkosic and quartzose petrofacies, which are indicative of uplifted continental basement, eroded or dissected arc plutons, deeply weathered cratonic landmasses, and/or recycled sediments. QpLvLs plots indicate a mixed composition between fold-thrust or collision suture belt, and magmatic arc provenance. Paleocurrents indicate an eastern source, in contrast with the hypothetical western and/or southern source identified for subacent units. This source is interpreted as either (a) a forebulge or major thrust block related with the development of the foreland fold-thrust belt, or (b) an uplifted basement block related to transpressive shear in the foreland region and to probable oblique subduction, both within the active continental margin setting. High-latitude climate and depositional environments are inferred to account for the more feldspathic composition of Upper Devonian and Lower Carboniferous sandstones, not strictly characteristic of recycled orogen provenances. A sample from the late Visean and early Serpukhovian Siripaca Formation presents vulcanoplutonic petrofacies, indicative of variably-dissected magmatic arc provenance. Limited data from this unit precludes further interpretation other than the record of Devonian or Early Carboniferous active magmatism previous to the Mid-Carboniferous regression. Sandstones from the Upper Carboniferous (?Moscovian) Yaurichambi Formation present varied petrofacies resulting from different local sources and recycling of sediment from underlying units. A continued influence of the magmatic arc provenance is observed in the same area as the Siripaca Formation, and is also recorded by the tuffs present within the carbonates of the overlying Copacabana Formation.

The overall sequence of compositional trends of Carboniferous sandstones in the Altiplano of Bolivia is interpreted as the foreland basin record of an active continental margin with local complexities and variabilities. Despite the effect of weathering, transport, sediment dispersal and diagenesis, detrital modes of sandstones remain



as a valid source of information in the identification of former tectonic settings. However, other geologic sources of information must be used in conjunction with provenance analysis before a definite conclusive statement can be established.

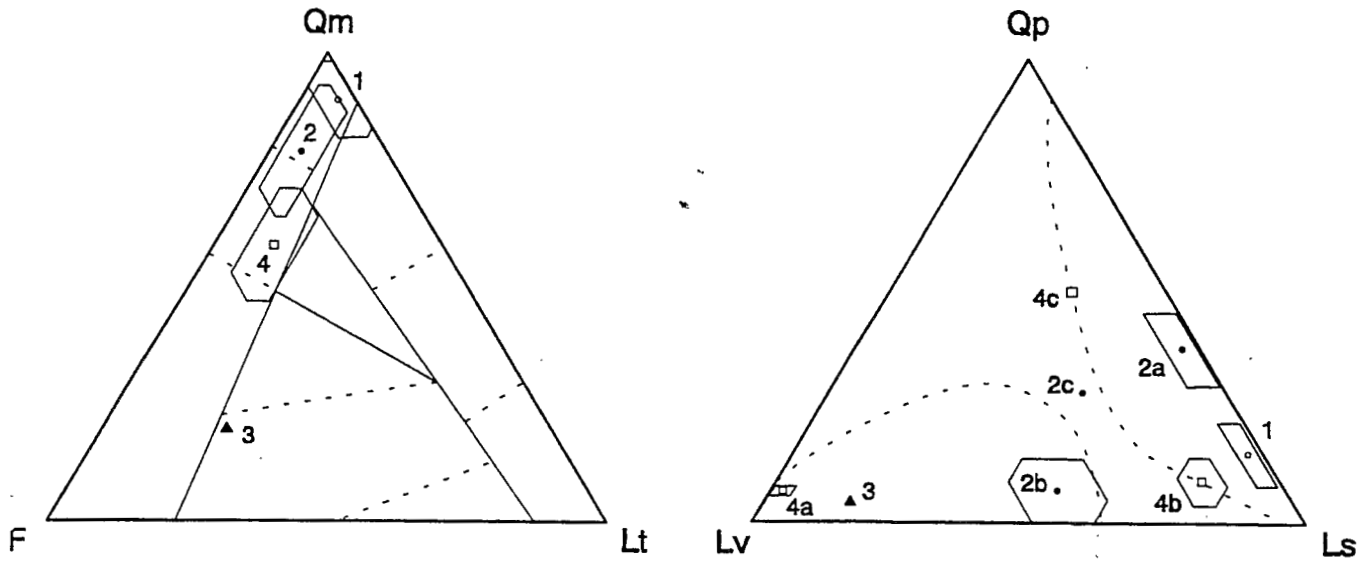


Figure: Distribution of mean detrital modes (plus one standard deviation) of sandstone suites derived from Upper Devonian and Carboniferous units in the Altiplano of Bolivia. Data in QpLvLs diagram is only for samples with  $Lt \geq 9$ . 1, Upper Devonian; 2, Kasa Fm.; 3, Siripaca Fm.; 4, Yaurichambi Fm.

# GEOLOGIE ALPINE

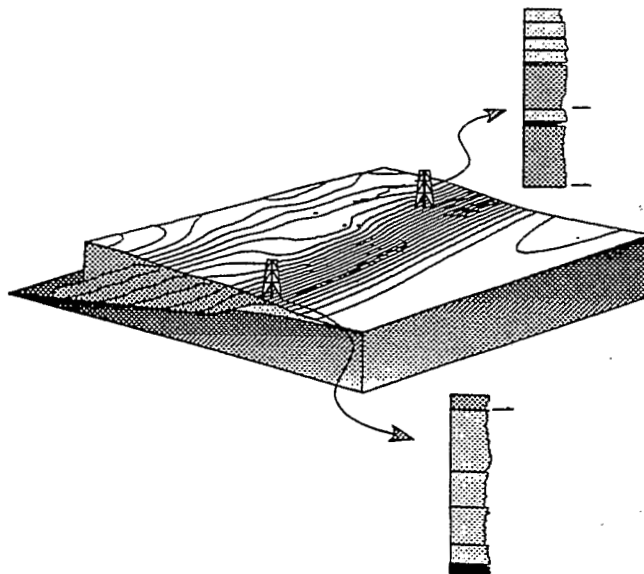
EDITE PAR LE LABORATOIRE DE GEOLOGIE  
DE L'UNIVERSITE JOSEPH FOURIER DE GRENOBLE

(Laboratoire de Géodynamique des Chaînes Alpines associé au CNRS)

Série spéciale "Colloques et Excursions"  
Tome 4



## Les bassins d'avant-chaînes



Organisation : P. Baby, J.-F. Gamond, G. Mascle, J.-L. Mugnier, M. Tardy

1994