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The relationship between the continental deposits of a lowstand wedge and the tectonic and magmatic processes at the Pacific continental margin: Example from the Upper Jurassic of the Neuquén Basin, Argentina

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The Upper Jurassic fill of the backarc Neuquén Basin includes a lowstand wedge known as the Tordillo Formation. The studied deposits crop out along a N-S oriented belt that runs parallel to the Andean magmatic arc. They are limited to the south by the east-west oriented positive structure of the Huincul arch formed as a result of Upper Jurassic tectonic inversion. The Tordillo deposits were formed in an arid fluvial-dominated system characterised by systematic downstream changes in architectural style. A gravelly and sandy bedload fluvial system is recognised in the southern upstream sector. The reduced thickness and the coarse grain size suggest steep gradients, excess of bedload supply and a low subsidence rate.

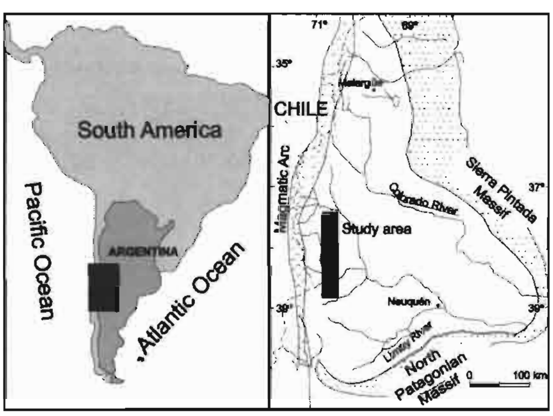

Figure 1. Location map of the Neuquén Basin. The rectangle shows the study area.

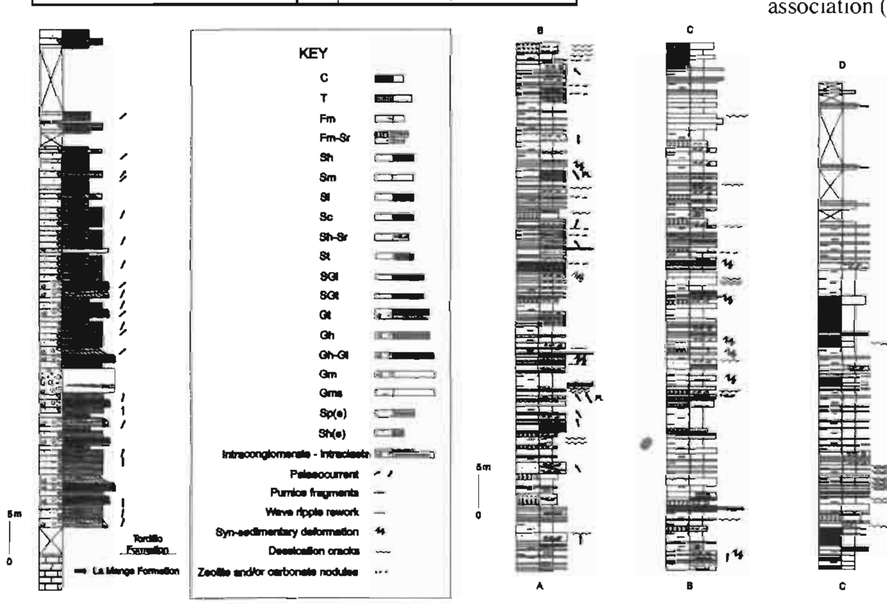

Figure 2. Sedimentary logs of the proximal facies association (Covunco) and the distal facies association (Loncopué)

Thicker and finer-grained deposits prevail to the north and northeast. They were formed under arid conditions in a wadi-sand flat-playa fluvial system. This distal facies association indicates increased accommodation owing to high rates of subsidence relative to coarse siliciclastic sedimentation rates. These low-gradient deposits are characterised by cyclic alternations of mud-dominated and sand-dominated packages interpreted as high- and low-accommodation systems tracts.

The overall fining upward stacking pattern of the Tordillo Formation suggests a change towards higher accommodation rates. This is accompanied by frequent development of soil horizons and darker primary and reworked pyroclastic deposits. These attributes indicate a stronger explosive volcanic activity associated with increased precipitation and high water table emplacement towards the end of the Tordillo lowstand wedge.

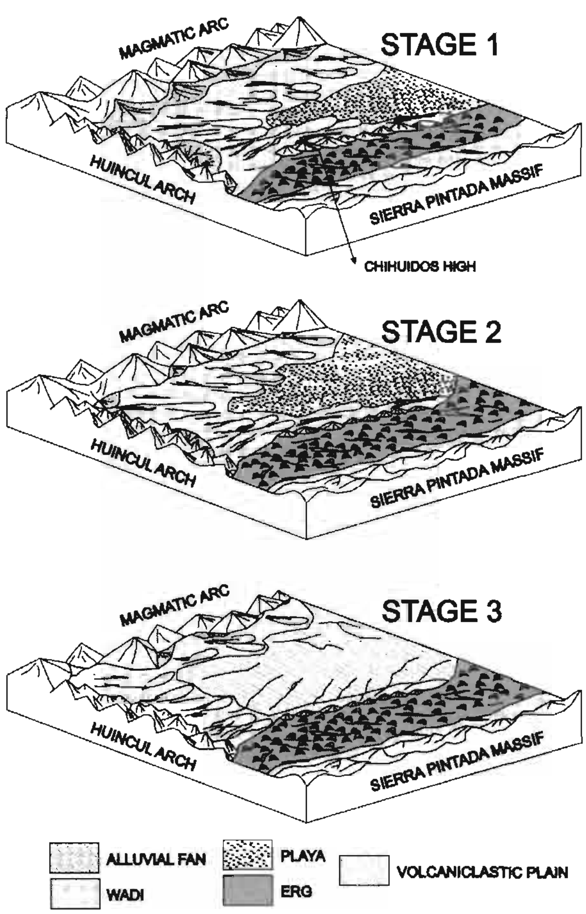

Figure 3. Schematic palaeogeographic evolution of the Tordillo lowstand wedge to the north of the Huincul arch. Note the development of two depocenters separated by the north-south trending Chihuidos structure.

The pebble composition of conglomerates, the framework composition of sandstones and pelitic rocks, and the major-element and trace-element geochemistry of sandstones, mudstones and prymary pyroclastic deposits are evaluated to determine the provenance and tectonic setting of the sedimentary basin. Conglomerates and sandstones derived almost exclusively from volcanic sources. The stratigraphic sections located to the south show a clast population of conglomerates dominated by silicic volcanic fragments and predominance of feldlitharenites. This framework composition records erosion of Triassic-Jurassic synrift volcaniclastic rocks and basement rocks from the Huincul arch, exhumed as a result of late Jurassic inversion. Towards the northwest, the conglomerates show a large proportion of mafic and acidic volcanic rock fragments, and the sandstones are characterised by a high content of mafic volcanic lithoclasts and plagioclase.

These data suggest that the source of these sandstones and conglomerates was primarily the Andean magmatic arc located to the west of the Neuquén basin. The clay mineral assemblage is interpreted as the result of combination of a complex set of factors, such as source rock, climate, transport and diagenesis. Post-depositional processes produced significant variations with respect to original compositions, especially in fine-grained deposits.

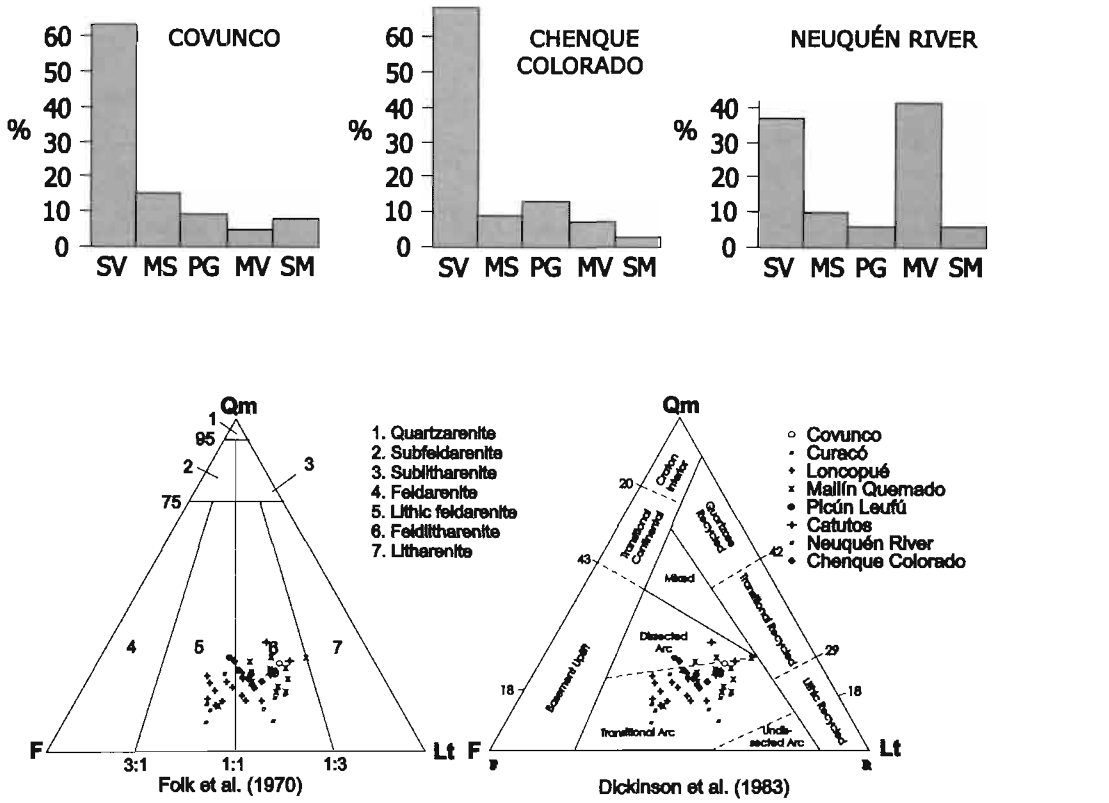

Figure 4. Histograms showing the pebble composition of the Tordillo Formation at the Covunco, Chenque Colorado and Neuquén River sections, and ternary plots showing detrital modes of the Tordillo Formation sandstones, sandstone classification (Folk et al., 1970) and standard provenance fields (Dickinson et al., 1983).

The Tordillo sediments are characterised by moderate SiO_2 contents, variable abundances of K_2O and Na_2O, and a relatively high proportion of ferromagnesian elements. The degree of chemical weathering in the source areas, expressed as the chemical index of alteration (CIA), was low to moderate. The major element geochemistry and the Th/Sc, K, Rb, Co/Th, La/Sc and Cr/Th values point to a significant input of detrital volcanic material of calcalkaline felsic and intermediate composition. However, major element geochemistry was not useful to interpret tectonic setting. Discrimination plots based on immobile trace elements, such as Ti, Zr, La, Sc and Th, showed that most data lie in the field for active continental margin. Yet, geochemical information was not sufficiently sensitive to differentiate between the two different source areas recognised by petrographic and modal analyses of conglomerates and sandstones.

References

Bhatia, M.R., 1983. Plate tectonics and geochemical composition of sandstones. Journal of Geology 92, 181-193.

Bhatia, M.R., Crook, A.W., 1986. Trace element characteristics of graywackes and tectonic setting discrimination of sedimentary basins. Contributions to Mineralogy and Petrology 92, 181-193.

Dickinson, W.R., Beard, L.S., Brakenridge, G.R., Erjavec, J.L., Ferguson, R.C., Inman, K.F., Knepp, R.A., Lindberg, F.A., Ryberg, P.T., 1983. Provenance of North American Phanerozoic sandstones in relation to tectonic setting. Geological Society of America Bulletin 94, 222-235.

Folk, R.L., Andrews, P.B., Lewis, D.W., 1970. Detrital sedimentary rock classification and nomenclature for use in New Zealand. New Zealand Journal of Geology and Geophysics 13, 937-968.

Gu, X.X., Liu, J.M., Zheng, M.H., Tang, I.X., Qi, L., 2002. Provenance and tectonic setting of the Proterozoic turbidites in Hunan, south China: geochemical evidence. Journal of Sedimentary Research 72, 393-407.

Irvine, T.N., Baragar, W.R.A., 1971. A guide to chemical classification of the common volcanic rocks. Canadian Journal of Earth Sciences 8, 523-548.

Johnson, M.J., 1993. The system controlling the composition of clastic sediments. In: Johnson, M.J., Basu, A. (eds.) Processes Controlling the Composition of Clastic Sediments. Geological Society of America, Special Paper 284, pp.1-19.

Maynard, J.B., Valloni, R., Yu, H., 1982. Composition of modern deep sea sands from arc-related basins. Geological Society of London, Special Publication 10, pp. 551-561.

Miyashiro, A., 1974. Volcanic rock series in island arcs and active continental margins. American Journal of Science 274, 321-355.

Roser, B.P., Korsch, R.J., 1986. Determination of tectonic setting of sandstone-mudstone suites using SiO_2 content and K_2O/Na_2O ratio. Journal of Geology 94, 635-650.

Vergara, M., Levi, B., Nyström, J.O., Cancino, A., 1995. Jurassic and Early Cretaceous island arc volcanism, extension, and subsidence in the Coast Range of central Chile. Geological Society of America Bulletin 107, 1427-1440.

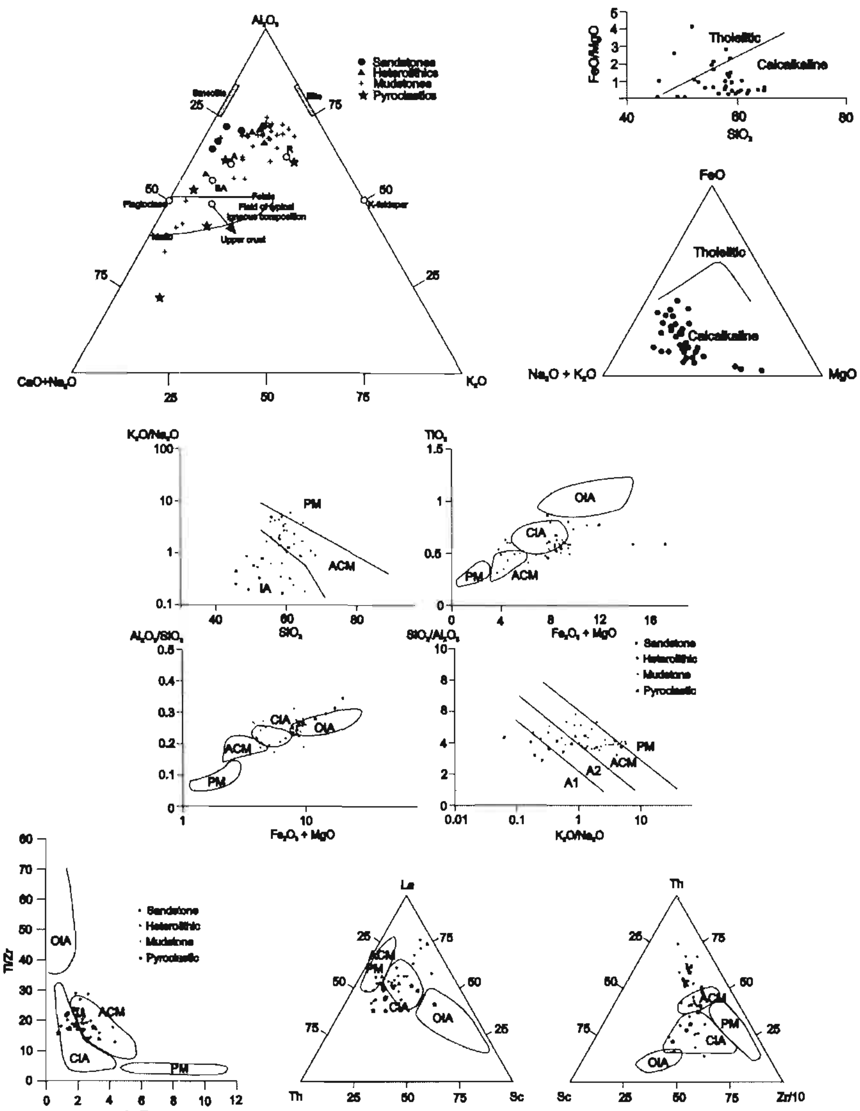

Figure 5. A: Ternary plot of Al_2O_3 – (Na_2O + CaO) – K_2O (CIA) for the Tordillo sediments. BA: basaltic andesite, A: andesite, R: rhyolite (Upper Jurassic Andean magmatic arc; data from Vergara et al., 1995). Note that most samples lie between the feldspar line and the clay mineral fields indicating a low degree of weathering. B: Plot of FeO*/MgO vs. SiO_2 used to differentiate calcalkaline from tholeiitic suites (Miyashiro, 1974) (FeO* is all Fe as FeO wt. %), and ternary diagram FeO - K_2O+Na_2O – MgO with boundary line between tholeiitic and calcalkaline fields from Irvine and Baragar (1971). These diagrams show the calcalkaline nature of the Tordillo samples. C: Tectonic setting discrimination diagrams based on major element proportions. K_2O/Na_2O vs. SiO_2 (after Roser and Korsch, 1986); TiO_2 vs. Fe_2O_3+MgO (Bhatia, 1983); Al_2O_3/SiO_2 vs. Fe_2O_3+MgO (after Bhatia, 1983); SiO_2/Al_2O_3 vs. K_2O/Na_2O (after Maynard et al., 1982; Roser and Korsch, 1986 and Gu et al., 2002). IA = island arc; OIA = oceanic island arc; CIA = continental island arc; ACM = active continental margin; PM = passive margin; A1 = arc setting, basaltic and andesitic detritus; A2 = evolved arc setting, felsitic-plutonic detritus. D: Tectonic setting discrimination diagrams based on trace element proportions (after Bhatia and Crook, 1986). OIA = oceanic island arc; CIA = continental island arc; ACM = active continental margin; PM = passive margin.