MODELLING THE EFFECTS OF CRUSTAL STRUCTURE DURING CONVERGENCE

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Kinematic models of oblique convergence by Tikoff and Teyssier (1994) and Teyssier et al. (1995) describe relationships between convergence direction and the orientation of instantaneous strain axes for models with various degrees of strike-slip partitioning on a margin parallel fault. Mechanical modelling by McKinnon (in prep.) of obliquely convergent margins has demonstrated that the major horizontal principal stress is always at a higher angle to the margin than the convergence vector despite reasonable variations in material properties. McKinnon has also shown that, where the margin is characterised by a margin-parallel fault of reasonable strength, thrust deformation will dominate either side of the pre-existing fault regardless of the convergence angle. The results of these two approaches to the problem are compatible and have implications for the interpretation of fault kinematics at plate boundaries which are, or have been, obliquely convergent in the past and which have margin or boundary parallel faults.

Segmentation of the Chilean and Argentine Andes is a function of rate and direction of convergence between the South American and Nazca plates, with the possible influence of long-lived lithospheric scale structures (Jordan et al., 1983). The history of deformation along such large scale structures in the over-riding plate is likely to have been complex given that the Cenozoic convergence history for the Nazca and South American plates has involved a progressive clockwise change in orientation (Pardo-Casas and Molnar 1987). Late Cretacceous motion of the Nazca plate was divergent with the South American plate at a very low angle, it then changed to more northeasterly directed convergent motion through the early Tertiary and became steadly oriented convergence at at high angle to the margin since the Eocene orientation (Pardo-Casas and Molnar 1987). Similarly, deformation along variably oriented crustal structures in Papua New Guinea during oblique convergence in the Tertiary is likely to be complex. A number of proposed crustal structures are considered related to mineral deposits in Papua New Guinea. These range in orientation but form two main groups, they are those which are approximately margin perpendicular and those which are approximately margin parallel (Corbett 1994). Because mineral deposits are often spatially related to crustal structures (e.g. Boric et al. 1990) modelling may be used to investigate conditions of deformation which may have contributed to the locations of mineral deposits at convergent margins (ie. the Andes and Papua New Guinea).

Mechanical modelling is investigated here as a tool for exploring the consequences of various convergence histories on the crustal structure of the Andean and Papua New Guinean margins. It has been carried out using the finite difference computer code FLAC (Fast Lagrangian Analysis of Continua, Cundall & Board 1988, Itasca 1992) on much simplified models of continental margin structure. The code has been successsfully applied to other studies of problems of stress distribution at a continental margin (e.g. Zhang et al. *in* press). Here we explore the possibilities for creating zones of dilation suitable for emplacing mineral deposits or mineral deposit-related intrusions located on or near continental margin, crustal scale structures. We describe the results of modelling some of these structures which may be related to mineral deposits.

The models presented form part of a series of models which progressively incorporate more complexity. The series of models are:

- the Falla Oeste as a planar, margin parallel fault with a variation in plate convergence angles representing strongly contrasting plate motions since the late Cretaceous;
- the Falla Oeste with a more complex yet generally margin parallel, non-planar geometry with the same variations in convergence angles;
- an approximately margin perpendicular structure from Papua New Guinea with convergence angle of approximately 55°.
- an approximately margin perpendicular structure together with a margin parallel structure from Papua New Guinea with convergence angle of approximately 55°.
- the Falla Oeste with a more complex yet generally margin parallel, non-planar geometry with the same variations in convergence angles and including the presence of an out-board margin parallel, planar fault representing the Atacama fault system.

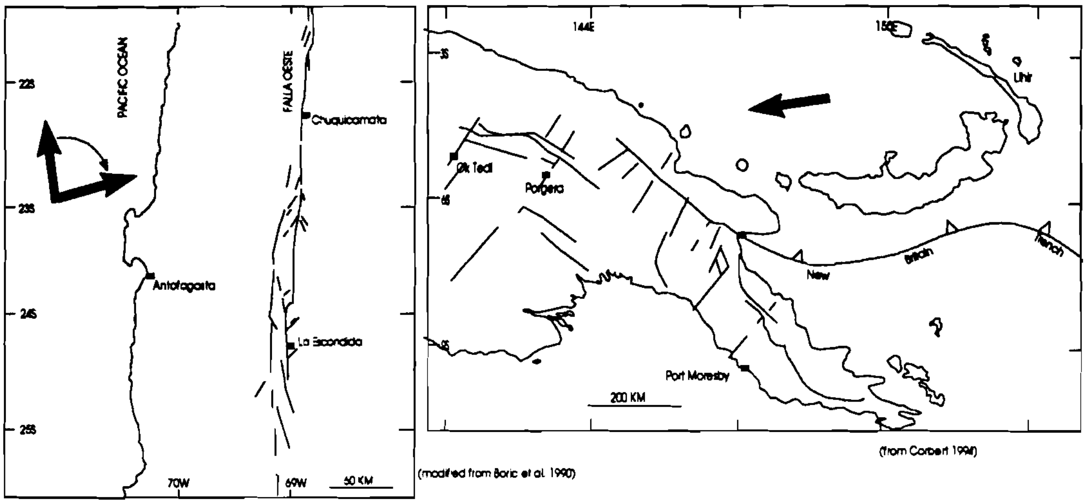

Figure 1. a) The Falla Oeste in the Chilean Andes and range of approximate Nazca plate convergence directions with respect to the South American plate since the late Cretaceous. b) Interpreted crustal scale structures in Papua New Guinea and current convergence direction of the Pacific plate with respect to the Austalian plate.

REFERENCES

Boric, R., Diaz, F., & Maksaev, V. 1990. Geologia y yacimientos metaliferos de la region de Antofagasta. *Servicio Nacional de Geologia y Mineria - Chile, Boletin no. 40.*

Corbett, G.J., 1994. Regional structural control of selected Cu/Au occurrences in Papua New Guinea. Proceedings of the PNG Geology, Exploration and Mining Conference 1994, Lae. Rogerson, R. (Ed.).

Jordan, T.E., Isacks, B.L., Allmendinger, R.W., Brewer, J.A., Ramos, V.A., & Ando, C.J., 1983. Andean tectonics related to geometry of subducted Nazca plate. *Geol. Soc. Am. Bull.* **94**, 341-361.

Pardo-Casas, F., & Molnar, P. 1987. Relative motion of the Nazca (Farallon) and South American plates since Late Cretaceous time. *Tectonics* **6**(3), 233-248.

Tikoff, B., & Teyssier, C. 1994. Strain modeling of displacement-field partitioning in transpressional orogens. *J. Struct. Geol.* **16**(11) 1575-1588.

Teyssier, C., Tikoff, B., & Markley, M. 1995. Oblique plate motion and continental tectonics. *Geology* **23**(5) 447-450.

Zhang, Y., Scheibner, E. Ord, A., &. Hobbs, B.E. 1996 Numerical modelling of the eastern Australian passive margin.. *In press Australian Journal of Earth Sciences.*