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Deep Crustal Structure Of The Argentine Continental Margin From Seismic Wide-Angle And Multichannel Reflection Seismic Data

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The last phase of the break-up of Gondwana during the Late Jurassic and Early Cretaceous is associated with a complex history of rifting and magmatism on the conjugate continental margins of southern Africa and Argentine. The opening of the South Atlantic resulted in the development of passive continental margins of the volcanic type on either side. Along the Argentine margin this volcanic activity is documented by a 60-120 km wide, complex structured wedge of seaward dipping reflectors (SDRS) (Hinz et al., 1999).

The extensional forces causing the break-up of the South Atlantic at approximately 132 Ma and earlier phases of crustal extension in Permian/early Mesozoic times led to the formation of several sedimentary basins at the continental margins. Narrow, up to 2s TWT deep, and SW-NE striking half-grabens at the Argentine continental slope are clearly associated with the rifting processes that caused the continental break-up. The origin of the wide Colorado Basin that sit at a high angle to the ocean margin is more difficult to access.

The Colorado Basin is located off the coast to the south of the Buenos Aires province, having dimensions of 200 x 500 km (Bushnell et al., 2000).

The Colorado Basin complex is recognized as the southernmost of a series of aulacogenetic embayments whose axis are orientated transverse to the rifted continental margin. Other basins in this series include the Salado Basin and the Punta del Este Basin that extend northward along the Argentine and Uruguay shelf. Neither the Salado nor the Colorado Basin deepen regularly toward the continental margin; thus they are not the product of simple progressive extension and crustal thinning (Max et al., 1999). However, the origin of these basins, and the Colorado Basin in particular, is commonly thought to have been extensional faulting. This faulting probably took place along previous zones of weakening (i.e. basement wrench faults and/or ancient suture zones of preexisting Precambrian-Paleozoic arc-trench systems) (Stoakes et al., 1991). Urien et al. (1981) assume the development of the Colorado Basin along a zone of weakening of the late Paleozoic (Permian-Early Triassic according to Uliana & Biddle, 1987) Ventana Hills, that represent the western continuation of the Cape Fold Belt in South Afrika (e.g. Andreis et al., 1989; Dingle et al., 1983; Uliana & Biddle, 1987; Keeley & Light, 1993) and mark the transition from the stable Plata-Riberia (Rio de la Plata) craton in the north to the Patagonia terrane in the south (Ramos, 1988, Urien et al., 1995).

In 1998/1999 the Federal Institute for Geosciences and Natural Resources (BGR, Germany) acquired a seismic data set at the Argentine continental margin including 12.000 km multichannel seismic (MCS) data and two wide-angle refraction seismic lines. The latter run in E-W direction at 40° S across the Colorado Basin and at 43.5° S across the continental margin.

To reveal the deep structure of the Colorado Basin and the volcanic continental slope, both wide-angle and reflection seismic data were incorporated in an integrated interpretation of both data sets. In the refraction seismic data primary P-phases were identified in each receiver gather and a forward modeling technique was chosen to model their arrival times. The layers in the sedimentary succession and the basement layer fit the MCS data horizons. We will present the derived models from the refraction seismic data and discuss them in context with the MCS data and potential field data.

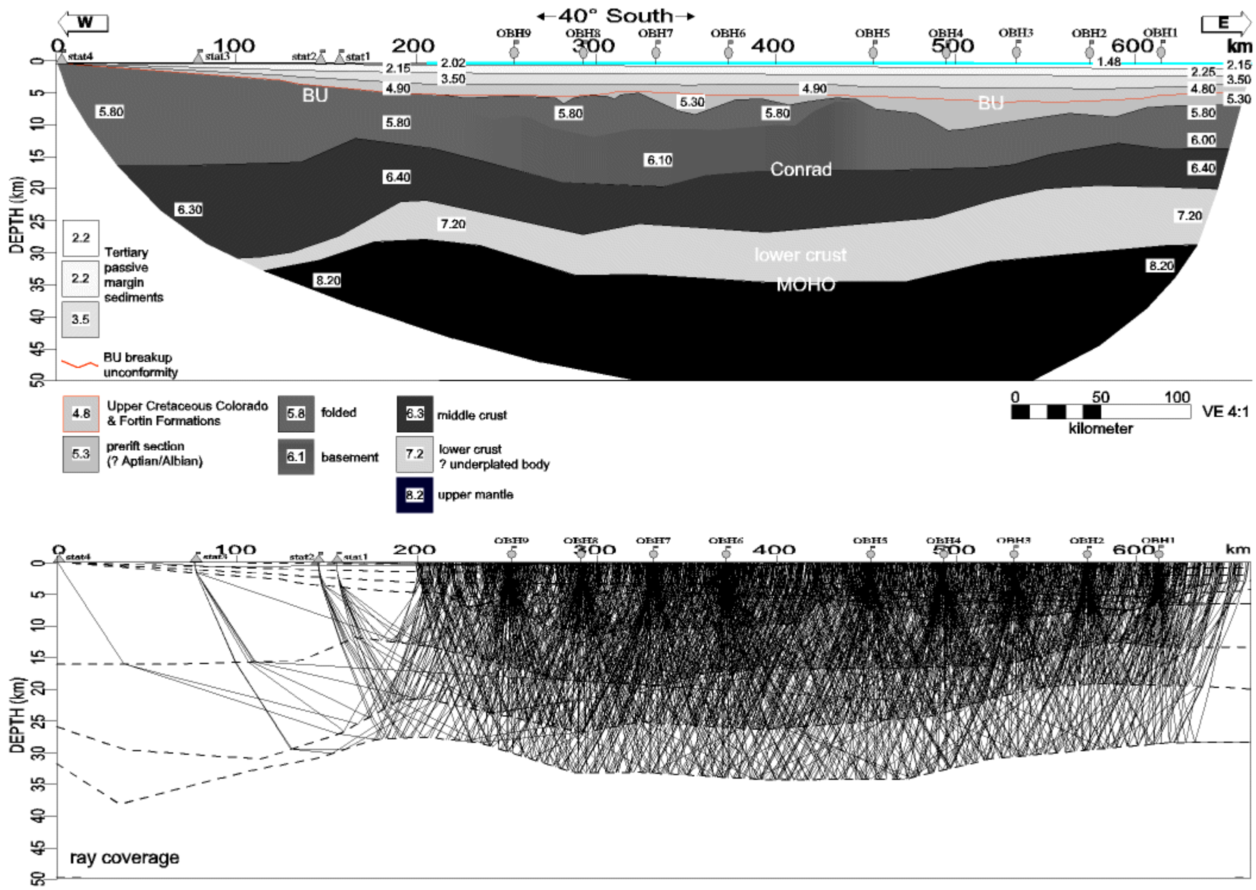

Fig. 1: Velocity-depth model across the Colorado Basin (top) and ray paths (bottom).

The Colorado Basin model (Fig. 1) shows up to 8 km of Late Cretaceous/Cenozoic sediments. It also shows a heterogeneous basement and a lower crustal layer with a velocity of 7.2 km/s above the Moho (velocity 8.2 km/s). Such a layer indicates intrusions of upper mantle material into the crust as it is expected during the continental break-up. However, the huge distance and the high angle to the ocean margin as well as a basement high, separating the Colorado Basin from the oceanic margin, argue against a development in conjunction with the final formation of the South Atlantic. We can not exclude the possibility that the Colorado Basin developed during an early extensional event (Permian – Triassic?) with the formation of the high-velocity lower crustal layer already in this time. But it might also be possible that the Colorado Basin represents an aborted rift in close connection with the development of the South Atlantic. In that case the rift axis must have switched from a NW-SE to a NE-SW direction. The interpretation of the Colorado Basin as an aborted rift structure would also explain the E-W orientation of the basins axis that sits on a high angle to the strike of the South Atlantic.

The Argentine continental margin model (Fig. 2) shows high similarity to the conjugated Namibian margin (Bauer et al., 2000). As for the southern African margin underplating (7.5 km/s layer) was found for the Argentine margin. The underplated layer is situated beneath the seaward dipping reflectors (SDRS). Highly thinned crust was determined in the area of the SDRS whereby the upper crust was affected to a higher amount than the lower. The internal structure of the SDRS wedge is subdivided into at least two separate sequences in the area of the refraction seismic line. The sequences are bound by strong unconformities in the reflection seismic data, show distinct variations in reflection characteristics (reflector curvature, reflector length/continuity) and show also different velocities of 5.6 km/s and 6.2 km/s, respectively in the wide-angle seismic data. From these observations we infer that the formation of the dipping layers along the volcanic margin of the South Atlantic was episodic.

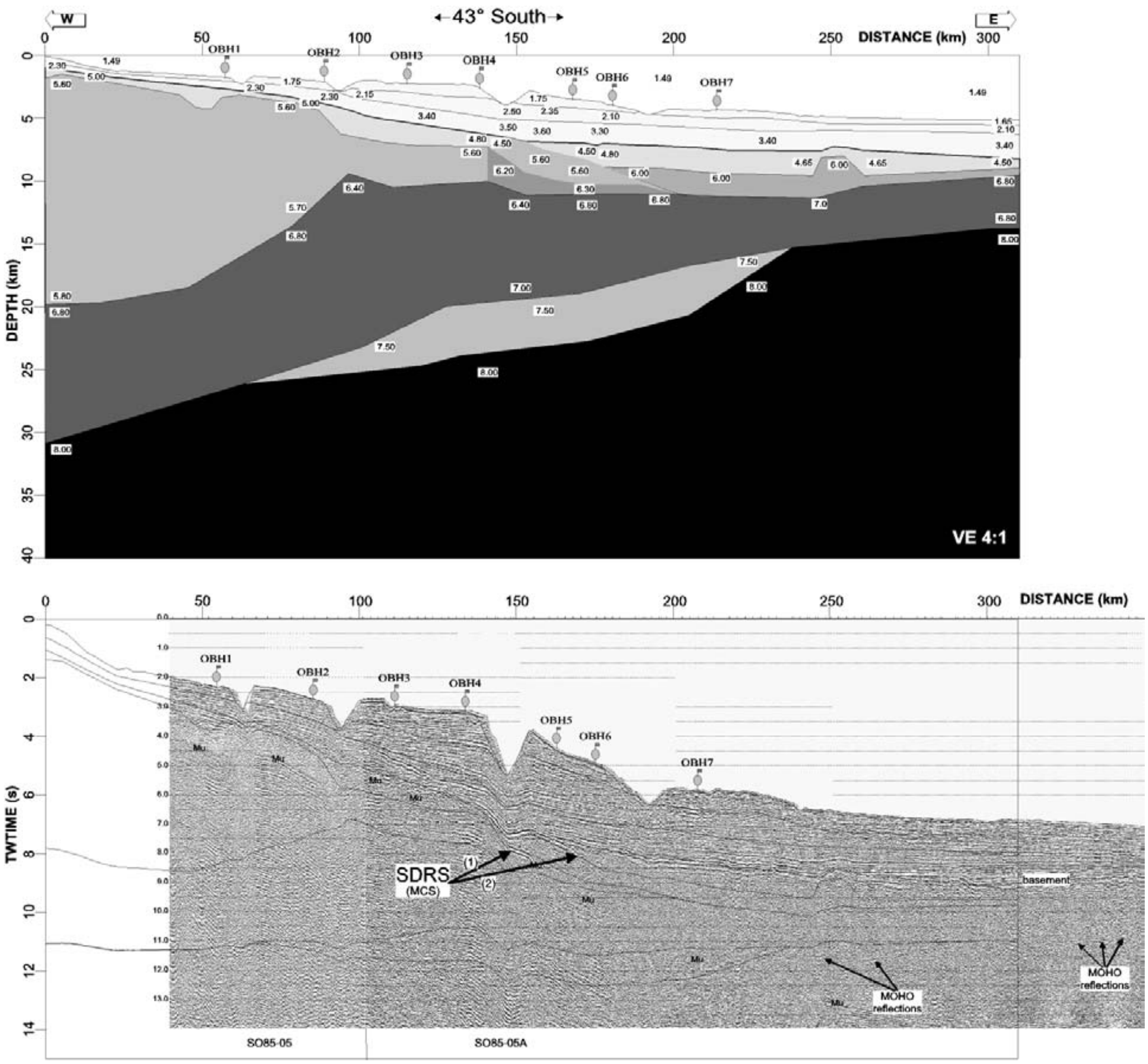

Fig. 2: Velocity-depth model across the Argentine continental margin (top) and reflection seismic line SO85-5/5a (bottom). In the lower panel the different layers derived from the wide-angle study which were converted to the time domain are overlain.

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