

Mechanism of subduction downbend as the cause of island arc curvature and back-arc opening: application to the Hellenic Arc and Cretan Sea and the reconstruction of the Hellenide Orogen

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Subduction downbend constitutes a rolling hinge moving across the oceanic plate. The continuing expulsion from the hinge, of material from the lower, viscous part of the plate, sets up a vertical excess pressure gradient which can support outer rises without elastic flexural contribution (Melosh 1977, Melosh & Raefsky 1980). A step-faulting mode of downbend is favoured (see companion paper), having quasi-cylindrical fault planes that provide such hinge-interior compression.

The world's highest outer rise (~1km) occurs in the Arica Bight, central Andean margin, where two-way 'flexure' of the plate restricts expulsion of the hinge material. Conversely, there is no outer rise at the Mariana arc, where the oldest generally recognized oceanic plate (170Ma?) is undergoing downbend. It appears that the bowing of the arc, and the related opening and northward propagation of the Mariana Trough at the rear, is a relieving response to the along-downbend distensive pressure developed in the lower part of the downbending plate. This is a form of the phenomenon well-known to engineers as *anticlastic curvature*, which occurs when a thick plate is bent strongly. It can be seen by flexing a flat slab of rubber. A similar mechanism is proposed for the Miocene bowing of the Hellenic Arc, with opening of the Cretan Sea, and it may cause the bowing of island arcs generally.

The Hellenide Orogen represents the SW-vergent closure of the 'Pindos Ocean' by thrusting 'Pelagonia' onto PreApulia. As the Hellenic Arc encompasses PreApulia its formation is post-Hellenide. The plate subducting at the Hellenic Trench is probably >200Ma old, so Mariana-type features may occur. The young Cretan Sea basin now separates the exhumed Hellenide UHP metamorphic slices of the Cyclades from HP ones on Crete. Closure of the basin (Angelier 1978) reconstructs the Hellenides. Precise geometry and dating show that the basin opened at ~18Ma by *separation*, like the Mariana Trough, not by Late Miocene stretching as proposed by Angelier.

The resulting Hellenide Orogen invites a synthesis similar to the Alps (see companion contribution). The NE margin of the Cyclades is identified as the old STE-advanced downbend line (Insubric Line analogue), showing exhumation of slices stacked at the downbend, derived from the SW edge of the undercut Pelagonia margin. Dates show STE at ~75-60Ma, main Hellenide closure at ~45Ma, and more closure at ~25-20Ma as subduction outboard of PreApulia began. (428 words)