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The significance of synchronous versus diachronous flysch successions and distribution of arc volcanism in the Alpine-Carpathian Arc[1])

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The narrow, 500 km long, Barremian-Eocene Flysch Zone of the East Alps ("Rhenodanubian Flysch"), which borders the East Alps in the north, continues eastward into the Silesian Nappe of the Carpathian Flysch which spans a slightly longer (Tithonian-Oligocene) period of deposition. The Carpathian Flysch Zone which extends to the southern end of the East Carpathians is much broader consisting of several depositional troughs - and is accompanied by huge Neogene volcanic centers of the Inner Carpathians. This is the basis for a plate tectonic interpretation of Carpathian geology in terms of subduction models (e.g. RADULESCU & SANDULESCU 1973). BLEAHU et al. (1973) in particular have suggested that the West and East Carpathians together represent an intracontinental volcanic arc. The lack of similar volcanism in the Alps has made it difficult in the past to apply subduction models to Alpine orogeny.

Paleogeographic continuity between the East Alpine and Carpathian Flysch Zones provides the justification for viewing the Alpine-Carpathian Arc as one orogenic belt. Assessing the roles of individual tectonic elements and their changes along strike of the arc may enable us to propose a tectonic model that simultaneously satisfies the known facts of the geologic evolution of the (East) Alps and the Carpathians. Essential features that must be explained are a) the presence of island-arc volcanism in the East and West Carpathians and the lack of such volcanism in the Alps, b) the diachronous nature of flysch successions in the East Carpathians in contrast to the synchronous nature of their equivalents in the West Carpathians and East Alps. It is proposed that the complex modern loop arcs in the West Atlantic - the Caribbean and South Scotia Arcs - may provide a model by which this is achieved.

In these modern loop arcs active volcanism is restricted to the east facing segment associated with the (west-dipping) subduction zone, whereas the "wings" of these arcs are transform fault zones marked by islands and, notably in case of the Caribbean, by the Puerto Rico deep-sea trench. These wings may have been formerly associated with subduction but act now as transform faults with dominant

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strike-slip motion (Molnar & Sykes 1969). (In some areas a component of convergent motion may still be active, e.g. along the southern boundary of the Caribbean plate in the South Caribbean Basin and Mountain System according to Silver et al. 1975, and Talwani et al. 1977.) Thus the Puerto Rico Trench may have been generated by subduction, which, however, has been dormant since probably Late Oligocene–Early Miocene time. Consequently this trench has accumulated a thickness of 1.7 km of undisturbed turbidite fill (Ewing & Ewing 1962).

The modern Puerto Rico Trench appears to be a suitable analogue for the Flysch Zone of the East Alps, which has been interpreted as a deep-sea trench filled with undisturbed turbidite successions when subduction was dormant for a period of 50 to 70 m.y. (Hesse 1981). The seemingly anomalous lack of arc volcanism in the East Alps (and its scarcity in the West Alps), which has been an enigma ever since plate tectonic interpretations were first attempted in the Alps, becomes understandable, if the northern plate boundary of Alpine Europe (the Austroalpine–Pannonian–Adriatic plate) was located in this proposed deep-sea trench of the Flysch Zone and if it functioned as a transform fault most of the time rather than a subduction zone. This hypothesis is supported by the lack of syndepositional deformation in the flysch deposits of the East Alps and West Carpathians except during minor, insignificant diastrophic episodes. At the same time that these synchronous flysch successions accumulated in the East Alps and West Carpathians in the East Carpathians, a strongly diachronous succession of flysch troughs with a well expressed diastrophic eastward polarity developed, indicative of continuing active subduction from Early Cretaceous to Neogene times, although only Upper Jurassic (Burchfiel & Bleahu 1976) and Neogene volcanics (mostly of Pliocene and Pleistocene age in the East Carpathians) are preserved. Recent seismic activity in Romania may be the last aftermath of this long-lived subduction zone (Roman 1970). The model would also require arc volcanism older than Neogene in the East Carpathians, but its traces may have been lost in tectonic sinks. In the West Carpathians abundant Neogene arc volcanics are related to the resumption of subduction in Miocene time, which ultimately eliminated the flysch-trench as a topographic feature. Apparently, this final phase of subduction was sufficient to produce volcanism in the West Carpathians but not in the East Alps, where it started earlier (in post-Eocene time).

The geodynamic link between the three loop-arcs – the modern ones in the West Atlantic and the ancient one in the Tethyan Sea – may be the westward drift of major lithospheric plates such as the two American plates in the Atlantic, between which smaller plates such as the Caribbean and South Sandwich/South Scotia plates remain relatively stationary (Jordan 1975), because they are "sheltered" behind westward dipping subduction zones that are more or less anchored in the asthenosphere (Kaula 1975, Tullis 1972). For the Alpine-Carpathian Arc this analogy would require strike-slip motion between continental and Alpine Europe, which would be sinistral. This sense of motion is also to be expected from relative motions, because in Cretaceous and earliest Tertiary times the Eurasian plate can hardly have moved eastward when opening of the North Atlantic had not yet started.

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