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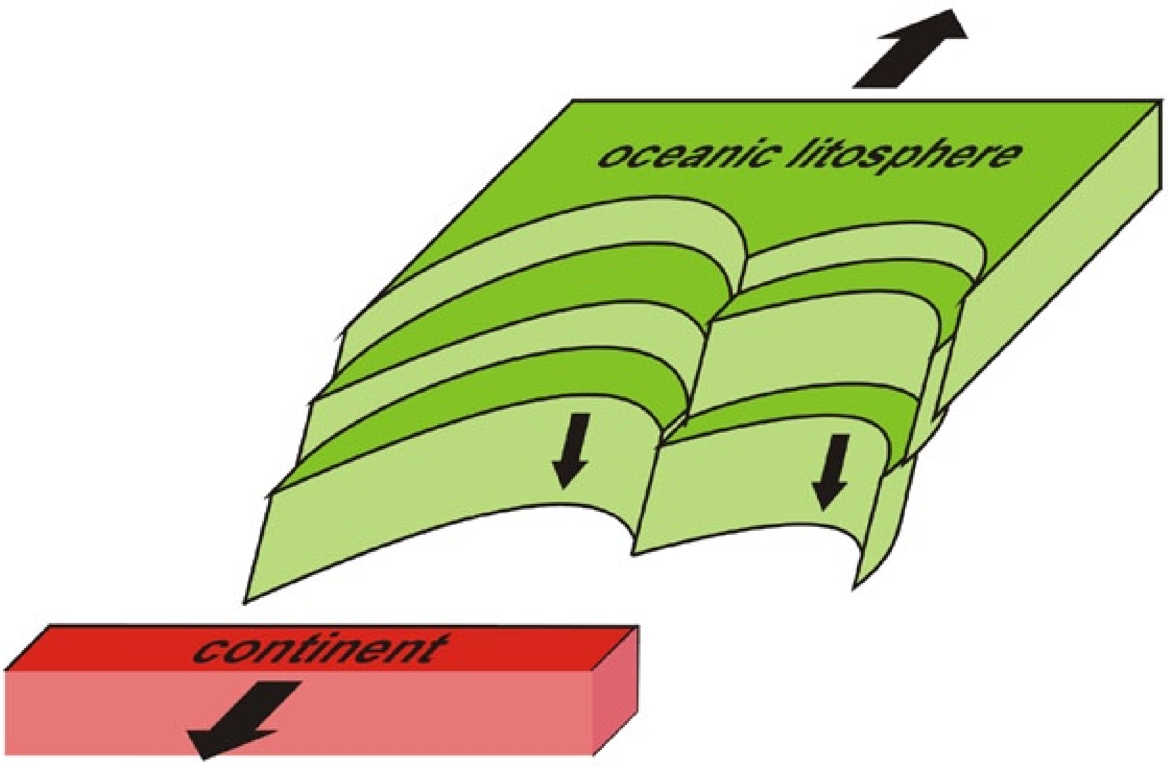

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TENSION – GRAVITATIONAL MODEL OF ISLAND ARCS

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Active continental margins are the zones where, according to plate tectonics, the oceanic spreading is being compensated. The original model, based on this assumption, was created by Isacs et al., (1968), being subsequently modified in different ways. Finally, it appeared as an artificial construction much less convincing than the model of spreading, and has been criticised by many authors (Tanner 1976, Carey 1977, Pfeufer 1981, Chudinov 1985, Koziar and Jamrozik 1991).

In clear disagreement with the plate tectonics model is a double seismic zone discovered beneath the Japanese Islands (Hasegawa et al., 1978) and the oppositely oriented tectonic regime in both planes of its hypocenters: almost horizontal tension in the lower plane, and similarly oriented compression in the upper plane (Figure 1).

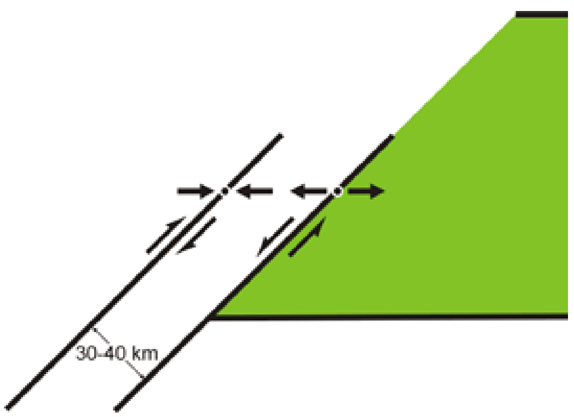

Figure 1*. The double seismic zone and strain directions in the upper and lower planes of the hypocenters.*

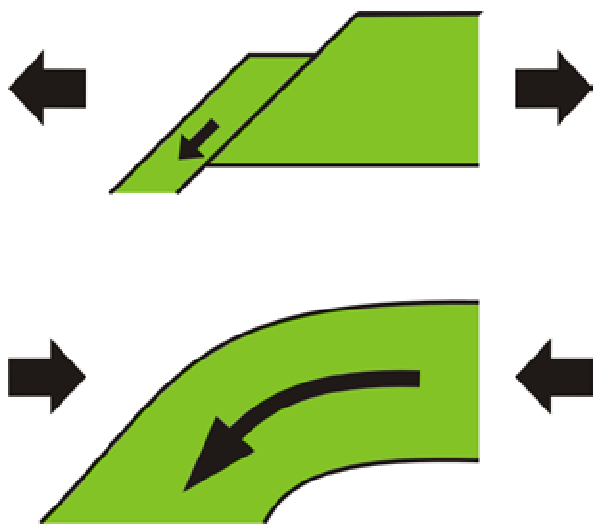

Figure 2. *a) The model of destruction of the lithosphere beneath island arcs resulting from Fig. 1.*
b) The plate tectonics model of deformation of the lithosphere beneath islands arcs.

The lower plane cuts the lower part of the horizontal oceanic plate. The distance between both zones is 30-40 km. The shear translations corresponding with the recorded tension and compression in relation to both plains of the hypocenters mean sliding down of the lithospheric material between these planes. This induces a scheme of the destruction of oceanic lithosphere shown in Figure 2a.

This model is in accordance with the tension beneath oceanic trenches and with evidenced here stepwise lowering of oceanic lithosphere along gravitational faults. It comes out from this model that the tectonic frame is the opposite to the plate tectonics model (Figure 2b). Moreover, it agrees with diapirism of upper mantle beneath active continental margins, which similarly to diapirism beneath ocean ridges, indicates tension regime, and also with back arc spreading, as well as the extensional development of marginal seas. The latter three processes have always been in strong contradiction with the plate tectonics model of plate collision.

The gravitational destruction of the oceanic plate shown above explains the bended shape of island arcs and the dip of Benioff's zones always inwards the arcs (Figure 3). A similar gravitational interpretation was presented by Carey (1976).

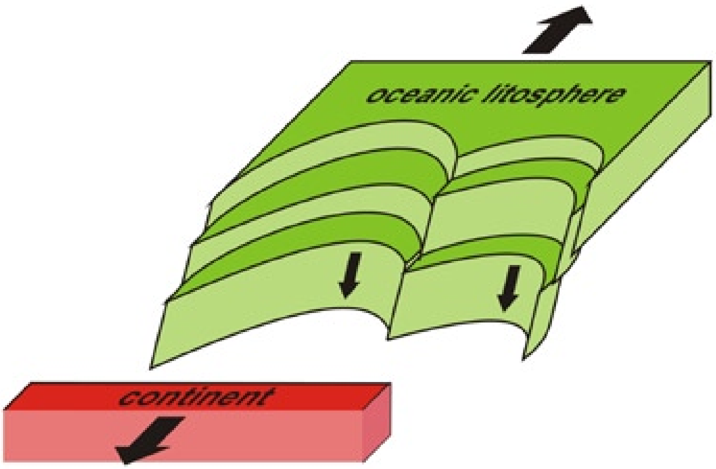

Figure 3. *The gravitational destruction of the oceanic plate determines the relationship between the bending of island arc and the dip of seismic zone.*

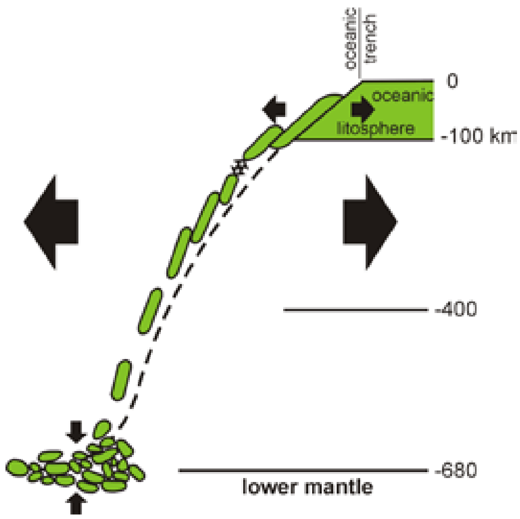

Figure 4. *The tension – gravitational model of the whole seismic zone.*

The tensional development of the Benioff's zones as a whole is shown in Figure 4.

The sinking of segmented oceanic lithosphere is caused by heating and decreasing density of the asthenosphere (which is well evidenced) beneath active continental margins. The thermal activation has the same cause as the gravitational destruction of lithosphere, i.e. an extension.

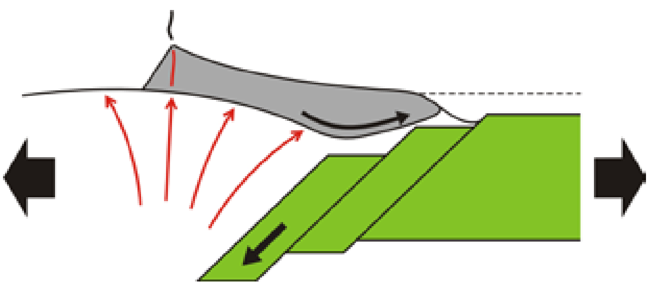

Figure 5. *The gravitational sliding of the island arc as a result of sinking of lithosphere in its front, and diapiric upheaval beneath the volcanic line.*

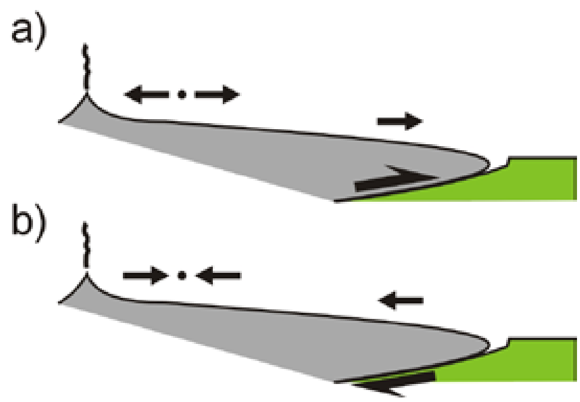

Figure 6. *Horizontal displacements of the rock masses in island arc in the case:*
a) gravitational overthrusting of the island arc,
b) underthrusting of the oceanic lithosphere (plate tectonics assumption).

The shallow part of the lithosphere between the oceanic trench and the top of the diapir, manifested as a volcanic line, must be gravitationally slided towards the trench (Figure 5).

Below we will prove this process.

The shear plane marked by shallow earthquakes beneath the island arcs is not a part of the Benioff's zone as assumed in the plate tectonics model. It dips gently towards the line of volcanos (Plafker 1965). Then, this plane can not be considered to support the scheme shown in Figure 2b. In spite, it can be interpreted as a plane of gravitational sliding. The latter interpretation is confirmed by a horizontal displacement of rock masses associated with the shallow earthquakes.

In the gravitational sliding, these masses should be transported trenchwards (Figure 6a); however, assuming underthrusting of the oceanic lithosphere (plate tectonics), they should be squeezed (Figure 6b).

The first case is true as evidenced by the data presented by Parkin (1969), Plafker and Savage (1970), Fitch and Scholtz (1971).

The gravitational sliding of the island arcs is also reflected in the vertical displacement of the rock masses. A characteristic feature of such sliding is rising of its frontal part and sinking of its distal part. This is a rule in active continental margins (Plafker, 1965; Plafker and Savage, 1970; Fitch and Scholtz, 1971).

In the scheme of Figure 5, two separate, but causally connected mechanisms can be seen. The first, the deep mechanism causes the slow subsidence of the area near the trench and, on the other hand, the slow rising of the area near the volcanic line. The second mechanism is the gravitational sliding, levelling the growing vertical gradient of the earth surface.

Many years ago both such mechanisms were recognized in gravitational tectonics by Haarmann (1926, 1930), who named them respectively, primary and secondary tectogenesis. The character of the first mechanism has always been difficult to define. In the active continental margins it can be deduced from recent well documented deep processes. The cause of the primary tectogenesis is evidently the break up of the lithosphere and the extension of the underlying mantle.

A similar model, though not reaching so deep into the mantle, was obtained by the present authors for intracontinental fold belts (Koziar, Jamrozik, 1985a, b; www.wrocgeolab.pl/Carpathians.pdf).

From both models it comes out that the active continental margins and intracontinental fold belts are not the place of oceanic spreading compensation. On the contrary, the lithosphere is being drawn aside also there, though to a less degree than at mid-ocean ridges.

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