4.1.1. CONVERGENCE BETWEEN THE ALBANIAN OROGEN AND THE ADRIA MICROPLATE*

Shyqyri Aliaj

4.1.1.1. Introduction

From the geological standpoint, Albania belongs to the Dinarides s. 1., the southern branch of the Alpine folded belt. The Dinarides s. 1. are separated by the Shkodra-Peja transverse structure into two: the Dinarides s. s. and the Hellenides. The Dinarides pass into the Hellenides in Albania, most of the country being encompassed by them.

The Aegean (Hellenic) Arc, visible in the southern part of the Hellenides, is situated between the Arabo-Africa/Eurasia collision to the east and the Adriatic collision to the west. The passage from the zone of the Aegean oceanic subduction to the Adriatic collision (zone of continental subduction) is accomplished by a transform fault at the western edge of the Cephalonia-Lefkas Islands.

The Mediterranean orogenic belt resulted from the movements of the vast African and European plates as well as small plates detached from them. The tectonic evolution of the Central Mediterranean was profoundly influenced by Adria, a block of continental lithosphere underlying Italy, Sicily, and the Dinarides, that behaved as a tectonic indenter during convergence between Africa and Europe (Channel at al., 1976).

The Albanian orogen is situated at the eastern margin of the Adria microplate. The boundary between the Adria microplate and the Albanian orogen seemingly runs along the morphological accidents in the Ionian and Adriatic Seas. It represents the Albanian orogenic thrust front, the westernmost one along the Adriatic collision zone.

4.1.1.2. Adriatic collision

Along the Albania-Greece southern convergent margin of Eurasia plate are distinguished a northern segment, belonging to the Adriatic continental collision, and a southern one, belonging to the Aegean Arc related with oceanic subduction.

Results inferred from GPS measurements show that the Adriatic collision zone in NW Greece (north of the Gulf of Amvrakia) is more or less stationary, whereas the Aegean Arc in Ionian Islands and Peloponnesus undergoes a pronounced SW-oriented movement (Kahle at al., 1995). This is in favour of the presence of an active transverse fault zone, termed Cephalonia fault zone, through which the Adriatic collision is separated from the Aegean Arc. The Adriatic collision takes place along the western coast of Former Yugoslavia, Albania and Central Greece (Fig. 4.1.1.2.).

The orogen in Albania and its surroundings is divided into two domains of different present-day tectonic regime: The external domain with compressional regime, constituting the Adriatic collision zone, and the internal one with extensional regime.

The Adriatic collision zone is the most seismically active one in the country; it represents the Ionian-Adriatic coastal earthquake belt at the eastern margin of the Adria microplate (Sulstarova at al., 1980, Aliaj, 2003).

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Numerous data on focal mechanism solution of shallow earthquakes show that horizontal compression (thrust faulting) dominates along the Adriatic collision, while an extensional field dominates behind it (Sulstarova, 1986, Muco, 1994).

4.1.1.3. Neotectonic structure of Albania

The orogen in Albania and its surroundings, in collision with the Adria microplate, is composed of a pile of nappe (allochthonous) sheets and is generally divided into two domains of different present-day regime: The external domain with compressional regime and the internal one with extensional regime. The neotectonic structure in the interior of the country has a horst-graben shape, due to the fracturation by normal faulting during the Pliocene-Quaternary, while in the external domain it is inherited developed (Aliaj, 1988, 1998).

Albania is one of the most seismically active countries in Europe. Most of strong earthquakes taking place in the country occur along well-defined seismic belts as follows:

a) **The Ionian-Adriatic coastal earthquake belt at the eastern margin of the Adria microplate, northwest-southeast extending.**
b) **The Peshkopi-Korca earthquake belt, north-south extending, and**
c) **The Elbasani-Dibra earthquake belt, north-east extending (Sulstarova at al., 1980, Aliaj, 2000).**

The neotectonic zonation of Albania is based on tectonic regime and types of deformations, which occurred. Four large neotectonic units have been recognized, each of them based on the sense, intensity and chronology of vertical movements (Aliaj, 1998), as follows (see numbers noted on Fig. 4.1.1.1.):

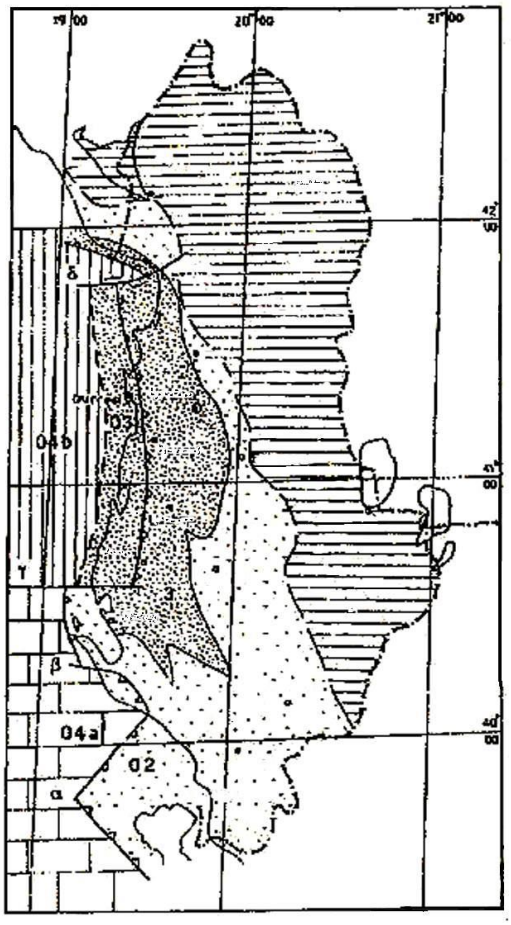

Fig. 4.1.1.1. Map of neotectonic (Pliocene-Quaternary) zonation of Albania (Aliaj, 2000).The four large neotectonic units are noted by numbers on the map (see text)

1. Internal area of Alpine folding affected by extensional tectonics since Pliocene
2. External area of Alpine folding strongly affected by pre-Pliocene compressional movements (02: its offshore sectors)
3. Periadriatic Foredeep strongly affected by post-Pliocene compressional movements (03: its offshore sector)
4. Foreland in Adriatic and Ionian offshore (04a: Apulian platform, 04b: Albanian Basin).

The orogen front from south to north is cut and displaced by the Othoni Island-Dhermi (a), the Gjiri i Ariut-Dukat (p) , the north of Sazani Island (y), and the Gjiri i Drinit-Lezha (8) transversals, which are showing on the map.

Some general features of the above-mentioned large neotectonic units of Albania are presented very shortly below.

Internal area of Alpine folding affected by extensional tectonics since the Pliocene comprises terrains east of the Kruja Zone. It is affected by a strong extensional regime during the Pliocene to Quaternary, which resulted in the establishment of horst-graben structures. As a consequence of this regime, shaping of the new lake basins within the grabens and of horsts and associated mountain chains continued until now.

The principal oddity of the neotectonic structure south of the Shkodra-Peja transversal is that the main pre-Pliocene structures extending NW are cut obliquely by the Peshkopi-Korca Pliocene to Quaternary graben fault zone, which extends N-S.

Faults bounding Pliocene to Quaternary depressions are normal, but have a strike-slip component.

External area of Alpine folding strongly affected by pre-Pliocene compressional phases includes terrains of Kruja, Ionian and Sazani Zones up to the offshore, these having been deformed by folds, reverse faults - thrusts and occasional back - thrusts as well as by strike-slips inherited from the main Alpine compressive phases which folded the above-mentioned zones. Weaker compressional movements continue up to the present.

The new structure of the external area derives from the ancient one. It developed with additional deformation during the successive orogenic compressive phases dominated by strong and progressive Pliocene to Quaternary uplifting. The general features of the area show that the geomorphology harmonizes with the structure.

Periadriatic Foredeep strongly affected by post-Pliocene compressional movements includes terrains both of hills and plains of the Western Lowland of Albania, which originated in the

- **Middle Miocene**

A number of north to north-west extending Mio-Pliocene linear and narrow anticlines together with wide synclines exist in the Periadriatic Foredeep. Seismic data show that the Mio-Pliocene anticlines are superimposed on thrust or back-thrust faults. Some secondary strike-slips have shifted anticlinal lines horizontally. Compressional deformations in Periadriatic Depression persist up to the present day.

Foreland in the Adriatic and Ionian offshore is situated west of the Periadriatic Foredeep and Sazani Zone, as well as west of the Ionian Zone to the south of Othoni Island-Dhermi transform fault.
In this Foreland, two different carbonate facies are distinguished, as follows:
a) The foreland with basinal carbonates, named the Albanian Basin or South Adriatic Basin, which is not affected by deformation, and
b) The foreland with platform carbonates, termed the Apulian platform, which is weakly deformed by normal faulting.

The Foreland in Adriatic and Ionian offshore constitutes the eastern part of the Adria microplate.

4.1.1.4. The Albanian orogenic front was thrust on the Adria microplate

Based on recent seismic explorations carried out, the convergence boundary between the Albanian orogen and the Adria microplate is fixed generally in Ionian and Adriatic off-shore.

The Albanian orogenic thrust front is cut and displaced by the Othoni Island-Dhermi, the north of Sazani Island and the Gjiri i Drinit-Lezha transversals of strike-slip type, which divide it in some separate segments with diachron development. The following below treated segments of the orogenic thrust front of Albania are distinguished (Fig. 4.1.1.2.):

- **The Lefkas-Corfu offshore segment of north-west extension,**
- **The Karaburuni-Sazani Island offshore segment of north-west extension,**
- **The Frakulla-Durresi mainly onshore segment of quasi-northern extension, and**
- **The Lezha-Ulqini offshore segment of west-northwest extension.**

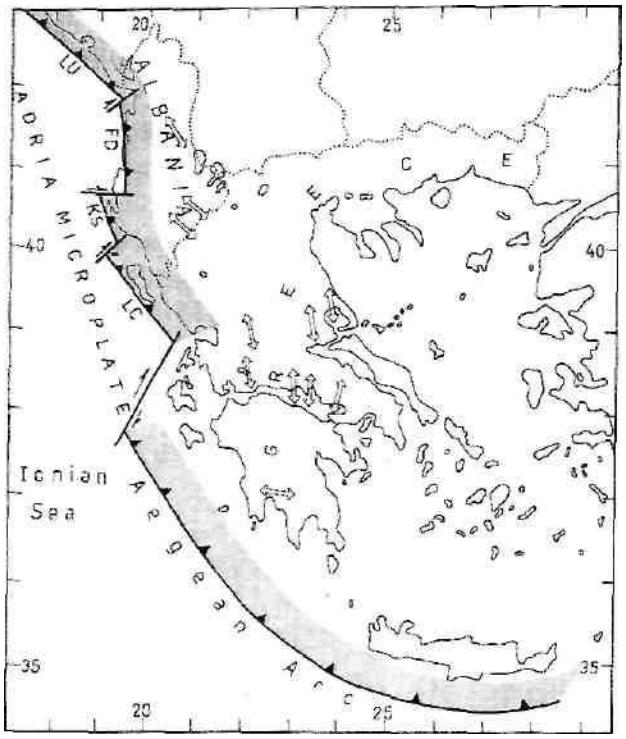

Fig. 4.1.1.2. Southern convergent margin of Eurasia plate: Adriatic collision and Aegean Arc
Segments of Adriatic collision frontal thrust are noted by capital letters, as follows: LC- Lefkas-Corfu, KS- Karaburuni-Sazani Island, FD- Frakulla-Durresi, and LU- Lezha-Ulqini.

The Lefkas-Corfu offshore segment of north-west extension; There is the Lefkas-Corfu slope where the orogen front, north-west extending, built by the Ionian Zone, was overthrust on Apulian platform (Sorel, 1989).

Further on, the orogenic front accords with the Othoni Island-Dhermi transversal, north-east extending, along the morphological accident in the transition from the continental shelf to the Ionian offshore bathial depths between the Island of Corfu and Himara town. Here a thin imbricated section of Ionian Zone was largely displaced south-west for a considerable distance and was overthrust on Apulian platform (Aliaj, 1998).

The Karaburuni-Sazani Island offshore segment of north-west extension. The orogenic front made up of the Sazani Zone north of the Othoni Island-Dhermi transversal begins with the continental slope south-west of the Mountain Mali i Kanalit where, as the result of some minor thrusts, the transition from the Mali i Kanalit back-thrust monocline to

the Apulian platform occurs. Here is observed that Upper Cretaceous carbonates were backthrust on Upper Triassic dolomites of Cika anticline of Ionian Zone, forming a triangular zone at the depth. North of Gjiri i Ariut-Dukat transversal, there is a large thrust, north-west extending, marking the passage from the Karaburuni-Sazani thrust front to the Apulian platform.

The Frakulla-Durresi mainly onshore segment of quasi-northern extension. Along a transversal extending east to west and north of Sazani Island, the transition from the Apulian platform to the Albanian Basin (=South Adriatic Basin) already occurs in the Adriatic offshore, and the front of the orogen is buried under molasse on the onshore coastal terrains of the Periadriatic Depression and may pass along the Frakulla-Durresi anticlinal line of quasi-northern extension, also in the Adriatic offshore as far as the Gjiri i Drinit-Lezha transversal where it is affirmed that the Ionian Zone actually comprises this front (Aliaj, 1998, Bega, 1995).

A number of north to north-west extending Mio-Pliocene linear and narrow anticlines together with wide synclines exist in the Periadriatic Depression. Seismic data have shown that the Mio-Pliocene anticlines are superimposed on thrust or back-thrust faults (Aliaj, 1988, Aliaj, 1971, Bicoku, 1964). These have been termed over-fault anticlines (Aliaj, 1971) or else determined as folds which Bicoku (Bicoku, 1964) described as being "placed in narrow zones of some big faults found under the Neogene cover". Some of these faults embody the "flower" structures of "palm tree" type (Aliaj, 1988).

The north extending Frakulla-Durresi anticlinal line has been subjected to dextral transpressional deformations due to oblique northeast-southwest regional horizontal compression in post-Pliocene time. That's why the "flower" fault structures of "palm tree" type were formed here at the same time with the folding of Periadriatic Depression. So, in Frakulla anticline a "flower" structure is observed, where the main fault is the east-dipping one of thrust type. In Ardenica anticline is also observed a "flower" fault structure of "palm tree" type, where the main fault, west-dipping one is of back-thrust type. In Divjaka anticline is seen another "flower" structure of faults, where the main fault, east-dipping one is of thrust type. In Durresi anticline the main fault, west-dipping one, is of back-thrust type, which incises even marine Quaternary sediments horizontally lying.

The orogenic front along the above segment is marked on the surface by thrusting or back-thrusting. Along Ardenica and Durresi anticlines, the thick clastic sediments of South Adriatic Basin (Albanian Basin), gliding on their top carbonates, were backthrust on frontal thrust structures of Ionian Zone, forming so triangular zones in the depth. It is important to underline that at Ardenica seismic cross-section, the all thickness of clastic sediments of South Adriatic Basin was largely displaced eastwards for many tens km (around 50 km), and it was strongly deformed into many anticlines and synclines.

The Lezha-Ulqini offshore segment of west-northwest extension. A passage of the orogenic front from the Ionian Zone, south of the Gjiri i Drinit-Lezha transversal, in the Adriatic offshore, to the Kruja Zone north of it, is assumed (Aliaj, 1998, Dragasevic, 1983). The buried orogenic front, north-west extending here, made up of the Kruja Zone, expresses with its large thrusting on Albanian Basin.

The above-mentioned local back-thrusting phenomenon, observed at the frontal thrust of the Adriatic collision zone, is quite different from the regional back-thrusting in Western Alps caused by Eo-Alpine and Apulian lithospheric wedging (Roure at al., 1990). In our case the Adria microplate (=Adriatic plate) is unaffected by such kind of wedging, since it was subducted during the Alpine deformation underneath Albanian orogen. The external tectonic zones (Sazani, Ionian and Kruja ones), which make up the orogenic fronts in Adriatic collision zone, constitute the large deformed units of the sedimentary crust, thrust one over the other towards the south-west.

The external margin of the fold and thrust belt in Albania and its surroundings was thrust on Adria microplate, partly over Apulian platform and partly over Albanian Basin.

The diachronism of the orogenic thrust front. The previous discussion demonstrated also that, along the convergence thrust boundary between the orogen and the undeformed Adria microplate in Albania, there is a diachronism. South of the Othoni Island-Dhermi transversal, the Ionian Zone is in the orogenic front, while, up to north of Sazani Island transversal, this front comprises the Sazani Zone. And on terrains of the Periadriatic Depression up to Gjiri i Drinit-Lezha transversal, the front is buried under molasse and apparently presented by the Ionian Zone. North of this last transversal, the front is in the Kruja Zone, again concealed under molasse. It is surmised that the diachronism results from incising and displacing of the orogenic front by all of the transversals mentioned above (Aliaj, 1998).

4.1.1.5. References

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