-13. - NEW GEOLOGICAL DATA ON THE TYRRHENIAN SEA

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Geological sampling and continuous reflection seismic profiling show two main stratigraphic units underlying the Tyrrhenian bathyal plain: a substratum and a sedimentary cover.

The substratum consists mainly of sialic rocks (migmatites, granites, augengneisses, micaschists, quartzphyllites, etc.) outcropping on some central-tyrrhenian seamounts (Secchi, De Marchi, Flavio Gioia) and elsewhere covered by thick basaltic lava flows (Magnaghi, Vavilov, Marsili, etc.). The substratum, quite similar to that of Sardinia but mainly to the metamorphic arch of Calabria and NE Sicily, is palaeozoic in age. Its metamorphism is hercynian, as demonstrated by the overlying lower permian rocks (Verrucano formation at Baronie seamount). The age of basaltic volcanoes is plio-pleistocene.

The sedimentary cover includes a rock sequence (marls, clays, sandy clays, sandstones, sands) ranging from Lower Miocene to Recent not thicker than 1500 m. It overlies unconformably the substratum. This aquitanian-langhian unconformity corresponds to the widely spread miocene transgression of Sardinia, Sicily and southern Italy. Almost everywhere a mid pliocene unconformity followed by transgression with coarse basal conglomerates is evident. From these data we infer that during the middle pliocene the tyrrhenian area was largely emerged as an archipelago of numerous large islands separated by channels. Since the middle pliocene i.e. about 4 million years B.P. a vast foundering (about 4500 m) of this area took place at an average rate of about 1,1 mm/year. Therefore, the present tyrrhenian sea is pliocene in age and may well be the youngest deep sea of the world.

The main tectonic trends of the bathyal plain (horsts, grabens, faults, folds) are oriented N-S in accordance with the axes of tectonic features known in Corsica, Sardinia and on their continental slopes.

Along the italian and sicilian slope there are numerous peri-tyrrhenian sedimentary basins, where the pliocene and quaternary sediments attain sometime thickness up to 2500 m. Mesozoic, palaeogenic and miocenic limestones, flysches and other very strongly tectonized apenninic formations are inserted between the middle pliocene transgression and the metamorphic substratum. Therefore the top of the latter is found deeper towards the surrounding lands (i.e. 5000 m, or more, along the coast of Campania). Only along the Calabria and NE Sicily arch the metamorphic substratum rises higher and is thrusted over to SE or S.

Three main mutually intersecting tectonic trends are clearly seen on the italian and sicilian slopes: NW-SE (apenninic), NE-SW (tunisian and transversal-apenninic), E-W (well developed across Sicily, southern Italy, Adriatic sea as far as Dalmatia).

On the basis of geological evidence it is possible to trace the boundary between the apenninic belt and its hinterland at the foot of the upper slope of Tuscany and Latium and of the lower slope of southern Italy and Sicily. This hinterland includes the northern Tyrrhenian area, the bathyal plain, Sardinia, Corsica and their slopes. It corresponds to microcraton or microplate not involved in the alpine orogenesis but chiefly subjected to up and down movements with very long emersion periods, during which the metamorphic substratum was deeply eroded and thinned; this was the main source of the clastics for the apenninic flysches. The metamorphic arch of Calabria and NE Sicily probably represents the eastern most front of the Corsica-Sardinia-Tyrrhenian microplate. This front is tectonically active also today as demonstrated by the deep earthquake foci.

The magmatic character of the tyrrhenian volcanism varies sistematically from the central area towards the peripherical ones as follows: a) tholeitic oceanic basalts (central-tyrrhenian volcanoes), b) alkali-olivine basalts (Palinuro, Ustica, Anchise seamts and Sardinia), c) hybrid i.e. basaltic-anatectic magmas (Pontine and Eolian islands, Enotrio, Lametino, Eolo seamts), d) anatectic magmas on the land (Tuscany, Latium and Campania). According to the radiometric dating all of these volcanoes are younger than 4,5-5 mill. years, mostly only 1 mill. years. That is, they are contemporary to the afore mentioned plio-pleistocene foundering and related to a coeval general extension in E-W direction of the Tyrrhenian area. Of course, the nature of the magmas reflects well the dynamics and the composition of the crust and the mantle.

From the few published gravimetric and refraction seismic data the central-tyrrhenian (i.e. bathyal plain) crust is semioceanic, the Moho being about 16 km deep (approximately 3,5 km of water, 1 km of sedimentary cover, 2 km of SIAL, 9-10 km of lower simatic crust).

This crust, apparently in disagreement with the cratonic behaviour of the central-tyrrhenian area, can be interpreted as the result of oceanization and thinning of an ancient (pre-cretaceous?) continental crust taking place during the apenninic orogenesis. The plio-pleistocene foundering (4500 m) of the bathyal plain in postorogenic extension regime of the tyrrhenian area corresponds to the isostatic adjustment consequent to the transformation of a continental crust (similar to the present sardinian crust) into the present semioceanic central-tyrrhenian crust.

This oceanization can be due to subaerial erosion of the SIAL and basal erosion and displacement of the lower crust by convection mantle currents ascending in the central-Tyrrhenian area and expanding laterally (mushroom like) towards an below the apenninic chain. This interpretation is in accordance with the geochemical character of the tyrrhenian volcanism and with the evolution of the apenninic geosyncline.

The focal mechanism of the deep southern tyrrhenian earth-quakes agrees much better with the geological evidence (expansion of the tyrrhenian area, volcanism, apenninic orogenesis etc.) assuming the hypothesis of a motion of the tyrrhenian microplate towards E and SE, carried by mantle currents, than by assuming a subduction towards NW of the Ionian plate below the calabrian arch along a Benioff plane dipping to NW, as postulated by a number of authors.

Interventions à la suite de la communication 4-13. - présentée par le Pr. SELLI :

PAPAZACHOS - Grèce.
When we see the earthquake foci plotted according to their depth on a conical surface it is misleading to show them one one plane. The focal depth is a factor of the distance from the axis.

Réponse - SELLI : I have plotted them in this plane, not directly but following axes parallel to the axis of the chain and the trends of gravity.

PAPAZACHOS - I have plotted them in the same way but it is a little different. Only 3 % are below this low velocity channel and only 2 % are deeper than 400 km. So we have a difference here.

There is new evidence that we cannot determine axes of compression and dilatation with focal mecanisms. We used to determine these axes by assumption. After works presented by McKenzie and al. you can find the relative motion between plates but not the axes of compression and dilatation. What is your opinion on this ?

Réponse - SELLI : I am a geologist. I have taken these data from the latest publications by Ritsema on these deep Tyrrhenian earthquakes.

BRINKMAN - Ismir.
In the Rome session I pointed out the similarity of the crustal structure of the Black Sea and of the Tyrrhenian Sea and explained the thinning of the crust in both cases by erosion, an uplifting of the sea-bottoms, of pre-Miocene age of course. Do you think this is a possible explanation with erosion of the former Tyrrhenian uplift and transport of the material to the adjacent geosynclines ?

Réponse - SELLI : Yes, of course, this is the hypothesis I have put forward. That is erosion and displacement of deep Tyrrhenian crust below the Appenine geosyncline.

BRINKMAN - No, I suggest just simple surface erosion of an old geanticline taking the place of the Tyrrhenian.

Réponse - SELLI : Surely after the Hercynian we have had a not very deep erosion of the crust. Generally the metamorphic rocks we have collected in the Tyrrhenian have been shallow depth metamorphics : only phyllites, very rare granodiorites, etc. The erosion was not very deep.

BARBERI - I have a lot remarks to make to the paper of Prof. Selli. Fot the sake of briefness I will limit the discussion to the volcanological aspects of the problem. Prof. Selli has neglected an entire class of data, namely the geochemical data and particularly the available strontium isotopic results. It is not possible to attribute to Eolian volcanics, and to Palinuro volcanic seamount, an hybrid origin, by mixing of basaltic magmas with sialic crustal material, if one considers that these rocks have a low strontium isotopic ratio of 0.703 - 0.705. It is furthermore not possible to treat as a single group rocks of completely different petrochemistry, i.e. calc-alkaline Eolian volcanics and alkaline potassic or silici alkaline or even peralkaline lavas such as those of Pontine islands. All these rocks were attributed by Prof. Selli to the so called perityrrhenian volcanic province. Similarly it is misleading to consider as a single group the alkali potassic leucitic volcanics of Central-Southern Italy and the anatectic silicic volcanics of Tuscany. Where the volcanic rocks of southern Tyrrhenian basin are treated properly, taking into account their geochemistry, a completely different picture emerges, as it will be shown in the following paper presented by P. Gasparini. In this context also the geological data, within the Tyrrhenian basin as well on the surrounding areas, may assume a different meaning leading to a coherent geodynamic picture quite distinct from that presented by Prof. Selli.

Réponse - SELLI : I shall be very happy to listen to your paper.

GLANGEAUD - Je tiens à féliciter le Pr. SELLI et suis entièrement d'accord avec lui. On peut essayer de préciser des éléments importants qu'il a fait apparaître dans l'Asthenosphère. En effet, dans le Monde entier celle-ci est divisée en deux niveaux entre lesquels il y a une zone d'incertitude avec une quantité moins grande de seismes. Sous les continents ces deux niveaux ne doivent pas évoluer avec la même vitesse car dans l'état de hautes pressions et températures où se trouve l'Asthenosphère Supérieure, il y a un léger changement d'état thermodynamique à l'échelle des temps et des espaces géologiques. Ceci a une certaine importance pour l'interprétation.

MULDER - Shell Intern.
You reporterd metamorphic and igneous rocks from the seamounts as Palaeozoic and Hercynian. Is it possible that part of these represent mesozoic metamorphic rocks as those found in Corsica or late alpine intrusives such as are found on Elba or Galite Islands ?

Réponse - SELLI : They are Hercynian metamorphic rocks because in some places they have been recovered by the Verrucano formation that is dated as Lower Permian in Sardinia and as a little younger in Tuscany. The Verrucano overlies always the Hercynian or Palaeozoic series in Italy.

MULDER - Is this Verruncano found on all seamounts ?

Réponse - SELLI : Not on all seamounts.