OCEANISATIONS OF EAST-MEDITERRANEAN CRUST, TAURIC AND AGEAN INDUCTED ARCS AND OPHIOLITES. (*)

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Oceanic or continental crust; tectonic implications.

Owing to its relative thinness (24-27 km), the East Mediterranean crust has been considered either as continental or as oceanic. Both interpretations have tectonic implications. An oceanic crust (Ryan, 1970; Biju-Duval, Dercourt, Le Pichon, 1976) is consistent with the plate tectonic concept of an Alpine subduction, the Agean arc being seen as an island arc of pacific type and Cyprus ophiolites as an upsurge of oceanic crust, either local or obducted (Gass, 1968). On the other hand, a continental crust is more in accord with the geological relations between the Tauric range and the Syrian platform (Ricou & al., 1975) and with analogies suggesting a continuity between the Syrian platform and the outer zones of the Hellenids (Brunn & al., 1976).

The most recent geophysical data (Morelli, 1978) are in favour of the continental nature of the crust. The problem, then, is the cause of the thinning of the crust, of the depth of its top surface under the sediments. The indications of an evolution towards pelagic facies of the platform mesozoic series near the east Mediterranean coastline (A. Bein & G. Gevirtzman, 1976) are also relevant to this problem.

Forced subsidence and sub-crustal digestion.

That there is a link between the thinning of the crust and the depth of its top surface, is shown by their systematic association in various basins, both marine and continental: southern Caspian and Black Seas, Eastern Mediterranean, Pannonic and Po basins. All these basins have in common the fact that they are either near or surrounded by recent ranges and that they may be considered as having undergone a forced subsidence. The folding of a range and especially the piling up of nappes overburdens the mantle which sinks under the extra load. This generates the mountain "roots" discovered by Bouguer and Pratt, origin of the isostatic theory developed by Airy and Dutton. Owing to the elastic rigidity of the crust, the adjacent areas are forced down together with the sinking range. This forced subsidence is different from the free foundering of grabens. It is this mecanism that generated molassic troughs in front of folded ranges: Swiss molasse, Coal Furrow along the Hercynian front, etc.. The profiles of the Caspian and Black Seas as well as of the Eastern Mediterranean, clearly express the identity of these phenomena: maximum sinking near the range, and (Morelli, 1978) traces of thrusting in the troughs along the contact. The negative free air anomalies are all the more significant for being associated with subsidence and not with the expected isostatic surrection. The subsidence of Venice is in this category.

Forced subsidence may explain oceanisation. It entails an extra-pressure at the base of the crust, thus altering the p, t, c (pressure, temperature, chimical composition) equilibrium of the mantle. With the rise of isobars, a rise of the mantle material is to be expected, i.e.a digestion of the lower levels of the crust tending towards their assimilation to the mantle. Such processes, out of reach for experimentation, are nevertheless quite general: if the 60 Km roots of newly formed ranges are reduced to 30-35 Km under old massives, it is not through isostatic compensation of subaerial erosion, for if this were the case, only deep-seated metamorphic rocks should outcrop instead of superficial sedimentary formations. But thinning of the crust (oceanisation) occurs only when the overpressure is not due to local piling up of crustal material, but to forced subsidence of a normally thick crust.

Crustal overload and inducted arcs.

In the Eastern Mediterranean sea, the weighing down of the crust is due to the thrusting of the Tauric and Agean inducted arcs (Brunn, 1976). That this thrust is active and not (or not exclusively) due to underthrusting of the crust, is proved by the diverging translations in both arcs (SW, S, SE) and even more, by the converging thrusts on both sides of the Isparta angle (Brunn, Brunn & al., 1976; Gutnic & Poisson, 1970; Monod, 1976). The resistance of the crust to these deformations and the resulting accumulated strains can only accentuate the initial subsidences and related surrections.

The inductions and southward ejection of these arcs started during pper Eocene through a longitudinal constriction of the Anatolian-Hellenic area squeezed between the Calabro-Silician eastward arc and the Arabian wedge moving towards the N.,as shown by the dextral strike-slip behind the Zagros (Braud & Ricou, 1971) and the senestral strike-slip along the Levant and Pozanti accidents. Folding around the Arabic buttress is, quite normaly, different from that of actively thrusting inducted arcs and is not accompanied by similar crustal sinking. One question remains: was the induction and southward ejection of the arcs facilitated by a preexisting lowering of the sea-floor as suggested by the increasingly pelagic facies of many platform formations as one approaches the Levant shores (op. cit.) Interference with the Low Nile synclinal gutter and the end of the Pelusian line (Neev, 1975) should probably be taken into account.

Emplacement of ophiolitic nappes.

The continental nature of the East Mediterranean crust excludes an autochthonous or southern origin for Cyprus ophiolites. Their late-Cretaceous emplacement resulted from a mecanism different from arc induction. As was the case for the whole peri-Arabic ophiolitic crescent (Ricou, 1971) and the Tauric ophiolites, they were crushed out of a Zagric-North Tauric oceanic-orogenic channel through the closing up between the Asiatic and Arabic plates, then thrust upon the (lower) of the gap Arabic margin. Subsequently, the contact between continental plates beeing established, these nappes were partly remobilized by collision tectonics in the Zagros and in Eastern Taurids, and by inducted arcs in the Eastern Mediterranean realm

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Commentaire de M. Biju-Duval

1. Il est difficile de suivre Mr Sengor quand il parle de la fermeture d'un océan méridional au Miocène. Pour deux raisons :

- La première d'ordre géologique a été développée par M. Ricou ; en effet rien ne prouve qu'un océan existait encore à cette époque; au contraire, comme nous l'avions montré sur les cartes présentées à Split il y a deux années, il est normal de penser à une fermeture du domaine océanique au Crétacé ou à l'Eocène inférieur (ce qui n'empêche pas l'existence d'un bras de mer plus ou moins subsident jusqu'au Miocène);

- La deuxième est d'ordre géométrique ou cinématique : si l'on tient compte des positions de l'Afrique et de l'Europe et de leurs tailles respectives ainsi que celles (présumées) de l'Anatolie, la collision continentale s'effectue du Crétacé supérieur à l'Eocène (ce qui traduit la variation brutale du mouvement relatif de l'Afrique par rapport à l'Europe à partir du Maestrichtien.

2. Par contre, comme nous l'avons développé d'une part avec J. Letouzey et L. Montadert dans les Initial Reports du DSDP (Vol. 42 A) et d'autre part avec J. Dercourt et X. Le Pichon (Symposium de Split), nous sommes d'accord avec C. Sengor et en désaccord avec MM. Brunn, Ricou et al. en ce qui concerne la Méditerranée orientale. Il me paraît inexact de dire que la Méditerranée orientale a une croûte continentale. Compte tenu de l'épaisseur de sediments, il s'agit d'une croüte mince dont il faut expliquer la genèse et l'âge de formation. En tenant compte à la fois des données de géologie des bordures terrestres et de géophysique les plus récentes en faveur de marges continentales mésozoïques au Nord de l'Afrique, on ne peut résoudre le problème en décrétant qu'il y a subsidence forcée. Par exemple, il est difficile d'expliquer la subsidence éocène décrite au Sud de la mer Ionienne grâce à la tectonique récente (moins de 10 MA) de l'arc hellénique.

Le projet de plongées sous les escarpements qui bordent la mer Ionienne dont je vous ai parlé, est susceptible d'amener de nouvelles informations permettant de choisir entre les différentes hypothèses.