Structure of the Eastern part of the Cyprus Arc

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During the first "Training through Research" cruise (*R/V "Gelendzhik"*, 1991) the eastern part of the Cyprus Arc was investigated by gravity and magnetic survey, as well as high resolution seismics. Two- and three dimensional gravity modelling of the intensive ΔG_B anomaly over Cyprus has been fulfilled on the base of data already available and newly obtained. The modelling allowed to define a position of the main density boundaries in the Earth's crust and geometry of the anomaly-forming body. The results of gravity modelling, justified by accompanying magnetic modelling, show that a large ophiolite body has been emplaced here into continental crust. The lower body boundary is situated at the depth of about 10 km, the upper boundary rises from east to west from 9.5 km depth and outcrops as the Troodos Massif in Cyprus. West of Cyprus this ophiolite body is cut by a deep fault.

The modern southern boundary of the Turkish Plate in the studied area passes between Cyprus and Eratosthenes Rise, along the Hecataeus Ridge south flank and its eastern continuation, the West Tartus Ridge, that has been traced till the Syrian upper continental slope. A pattern of gravity field, thickness and composition of the Earth's crust and mode of sedimentary cover deformation change sharply across this plate boundary.

No signs of subduction of the African lithosphere have been recorded along the West Tartus Ridge. The ridge was interpreted as a large steeply south- and southeastward thrusted sheet likely to be made up of the Palaeogene sedimentary rocks (Fig. 1). The Messinian evaporites pinch out against the ridge slopes. The similar but not so extensive thrust structures were found to the North, between the West Tartus Ridge and underwater prolongation of the Kyrenia Ridge. This system of southward thrusts originated possibly in the Oligocene-middle Miocene time, when the convergence of the African and European Plates was northwest directed (LETOUZEY, TREMOLIERES, 1980; RICOU, 1980; LIMONOV *et al.*, 1992). Since the late Miocene time, when the convergence direction became northeasterly, the thrust sheets suffered a lateral displacement along the wrench fault system stretching from Cyprus (BAGNALL, 1964) to Syria to form step-like configurations of their coastlines. All shear sheets are moving in general to the west, the value of westward displacement decreasing gradually from the southern sheet to northern one. Small pull-apart basins were formed inside some sheets due to latitudinal separate ophiolite bodies, rest on the deep fault (possibly deep dextral wrench fault) traced approximately from the Nile Delta into the Antalya Gulf. As a result of such kinematics the lateral crust shortering and ophiolite piling take place, reflected in intensive gravity high over Cyprus.

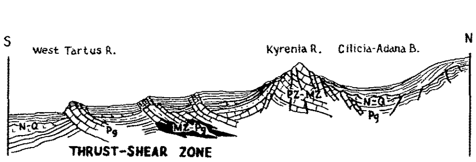

Fig. 1.- Schematic geological cross-section of the Cyprus Arc along 34°40'E.

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Shallow-water vs deep-water depositional model - A new interpretation of Lower to Middle Miocene salt formations of the Carpathian foredeep molasses.

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The Carpathian foredeep is a typical syn- to late orogenic, mainly epicratonic (peripheral) foreland basin of Late Alpine age. The origin of this foreland basin is due to lithospheric flexure in response to loading by multiple overthrust sheets. The basin is filled with thick sequences of siliciclastics containing evaporite units. The source areas of the molasse-fill where the rising and growing accretionary prism of the deforming Carpathians and/or the rising compensation wall landwards of the basin.

The basin is generally divided into two subbasins : the internal and external ones, the first being now buried beneath, the second - in front of the thrust belt. Within the first, molasse sedimentation start in Egerian (Late Oligocene to Aquitanian) and terminated in Lower Badenian (Langhian) time. These form the lower molasse complex of authors (e.g. VIALOV, 1965). Within the second, sedimentation start in Lower Badenian and terminated in Upper Badenian (Serravalian) time to the W (Moravian sector) or Pannonian (Tortonian) time to the E and SE (Ukrainian and Roumanian sectors) of the foredeep basin. These form the upper molasse complex of authors (e.g., VIALOV, 1965).

For the upper molasse complex a shallow-water, marine to deltaic depositional system is commonly accepted and will not discussed here. But for the lower molasse complex of the internal subbasin no general accepted depositional system exist, although most authors agree that sedimentation start in a deep-water environment (e.g. , OSZCZYPKO, 1982). The lower molasse complex is composed of three successive sequences which overlap each other in a prograding, transgressive manner and are separated by erosional and/or tectonic unconformities. Within each of these salt-bearing units, including potash-salt lithosomes occur. For these the classic evaporative genetic model is accepted. Consequently, a shallow-water to coastal sabkha or continental playa depositional system for at least these units is accepted. The presence of rip-up breccias, dessication cracks, potash-salt lithologies, bird and other land-animal footprints apparently confirm this model.

However, paleontological, both paleobotanic, macro- and microfloral and paleozoological data on terrestrial great mammals point to a warm and humid, sometimes even wet climate during the Lower and early Middle Miocene time, i.e. during the whole time of the deposition of the salt units within the successive molasse sequences cited. There are other aspects of the geologic setting, lithology, mineralogy and geochemistry of the salt units which are in many respect quite unusual : (1) they pass laterally, towards the deformation front, into syndiastrophic offscraped, coarse-clastic flyschoidal or flysch deposits of the final miogeoclinal or initial foredeep throughs ; (2) they overlap transgressively the peripheral (landside) slope of the outwards migrating molasse basins ; (3) they commonly presents features of redeposited sediments, i.e. of olistolithic, olistostromic, submarine slump or debris flow and turbiditic deposits ; (4) they are composed of zubers, i.e. clay/halite mixtures with halite saturation index values of 0,1 to 0,4 only ; (5) potash-salts occur as intercalations or irregular bodies at any plane within the whole vertical section of the individual salt formations ; (6) the bromine profile through halite sequences are irregular, not smooth, decreasing, not increasing upwards ; (7) the salts posses abnormal hight concentration of Ba and Sr ; (8) within the salt formations normal marine metazoans are quite common. All these pecularities suggests that salt-bearing units within the successive molasse sequences filling the internal subbasin of the Carpathian foredeep basin are not of evaporitic origin. They were formed as precipitates from superconcentrated formation brines expulsed from the deforming and thrusting accretionary prism and from hyperconcentrated dissolution brines resulting from subrosive leaching of tectonically canibalized older salt units of the preceeding molasse sequences underplated along the decollement surface (LISZKOWSKI, 1989). The salts were deposited at relative great depths ranging from approx. 300 to 600 metres. The depositional and postdepositional structures that apparently are suggestive for a shallow-water to supratidal-lagoonal or saline depositional subenvironment can be equally good or even better interpreted to support the suggested deep-water depositional model : the apparent rip-up breccias and desiccation cracks are syngenetic and/or eodiagenetic structures resulting from hightenergetic seismic pulses which accompanied the thrusting process, potash-salts were the result of precipitation from hyperconcentrated dissolution brines e.t.c.

The suggested genetic and depositional model for the Lower to Middle Miocene salt formations discussed challenge the whole depositional system of the lower molasse complex of the Carpathian foredeep into an extremely dynamic, orogenic sedimentation model. According to this model all their elements : spatial-time facies distribution and succession, lithologies, basin depth and subsidence ratio, thicknesses, sea-level changes, time of deposition initiation and termination e.t.c. where controlled by the timing, rate and intensity of the thrusting process.

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