7-4 - MODERN FLYSCH SEDIMENTATION IN A MEDITERRANEAN ISLAND ARC SETTING

by D.J. STANLEY - Division of Sedimentology, Smithsonian Institution
Washington, D.C. 20560 - USA.

Flysch, an orogenic (pre-paroxysmal) marine facies consisting of thick, repetitive terrigenous sequences, is generally an integral part of the sedimentary suite in geosynclinal belts. Literally hundreds of field studies conducted in the world's major mobile belts have detailed the tectonic, stratigraphic and sedimentological characters of these paleobasin deposit. Are there present-day analogs accumulating in today's oceans, and can the term appropriately be used to designate recent unconsolidated sequences ? Both questions can be answered by a qualified 'yes'. The Hellenic Arc in the eastern Mediterranean Sea is proposed as one such site of modern flysch sedimentation. Interestingly enough, this area borders the Hellenides, an extension of the Alpine chain which comprises some classic flysch formations.

The term flysch has enjoyed an ever growing popularity since it was introduced by Studer in 1827 but, like the concept of geosyncline, it has caused more than its share of philosophic and semantic arguments ! The term is used here for recurrent marine facies "which constitute a well-bedded sequence in an alpine-type mountain chain with a tectonic setting, and sedimentological features similar to the Alpine Flysch in its more typical development" (HSU, 1970). I see no reason to exclude young unconsolidated sediment from the definition of flysch if such sequences meet the geographic, tectonic and sedimentary conditions stipulated. In this regard, the complex tectono-geographic setting of the present Hellenic Arc presents many of the characteristics associated with the western Alpine region during the period of flysch development in late Mesozoic-Paleogene time.
The Medina Rise forms ridge crowned with a chain of three large and several smaller individual seamounts rising at an average spacing of 40 km. , above the sea floor. The lenghts of the larger, oblong seamounts are 45,35,25 km. counting from West. Their lenght-to-breadth ratio is 3:1 the longer axis being aligned NE-SW. The flanks slope over 15°. The heights above floor decrease eastward from 3600 m. to 700 m.

The seismic reflection profiles show the seamounts to be flat-topped tectonic blocks covered with more than 300 m. of sediments distorted and displaced by numerous faults. An 8 m. long piston corer sample showed sequences of intercalated foram lutites, tephra and a few sapropelic layers.

The positive Bouguer gravity anomaly is broad and of 150 to 200 mgals order. It is larger than the usual oceanic anomaly and suggests a high mantle topography-not necessarily expressed in the surface feature.

The magnetic anomaly is an elongated E-W oriented feature, up to 300 gammas strong, associated with the whole rise rather, than with individual seamounts.
The Medina Rise ands its seamounts are thus interpreted as a linear arrangement of tectonic blocks. They have sunk to a lesser depth than the adjacent sea-floor during the post-miocene foundering of the Ionian sea basin along the Sicilian Escarpment. The W-E alignment of the rise may be due to stresses caused by a major wrench -(transform) fault trend associated with relative lateral motion of the european & african plates suggested by other authors.

The Cyrene seamount is over 50 km long and 15 km wide. Its major axis show NNW-SSE aligment. The average flank slope exceeds 15°. Te seamount rises over 2600 m above the adjacent Ionian abyssal plain.

The seismic reflection profiles show it to be covered with at least of 400 m. of little disturbed stratified sediments tilting 1° to NW, in the opposed sense to the tectonic tilt of the Sicilian Escarpment. The top sediments show effects of submarine erosion and slumping. The seamount conforms to the usual characteristics of a guyot.

The refraction profiles showed on the east flank presence of (Mesozoic ?) sedimentary rocks (velocity 4.7 km/sec) at a shallow depth.

The region of specific concern lies between about 20° and 28°E Longitude and 33° and 37°N Latitude. It comprises, from north to south, an internal trough, an interior andesitic volcanic arc, an exposed sedimentary island arc, the Hellenic Trough (a broad depression containing a series of parallel trenches), and the broad arcuate Mediterranean Ridge. Geophysical studies of this area by other workers (gravity, heat flow, seismicity, including focal mechanism, volcanism) and deep drilling support a model of compressional convergent plate juncture, i.e., underthrusting of the African plate beneath the Eurasian plate (RYAN et al., 1970; and others). Ponded sediment to which the term flysch can be applied is found in the more than 25 depressions south of the Peloponnesus-Crete-Rhodes belt; circular to linear lows range in size from little more than 100 km2 to 10,000 km2, and in depth from 2000 m to just over 5000 m. Seismic profiles reveal thick (> 200 m) wedges of unconsolidated, stratified sediment in margin depressions, basin plains and some trenches. The age and intensity of deformation of strata resulting from syn-and post-depositional tectonic activity appears to decrease from north to south (RABINOWITZ and RYAN, 1970).

This migrating synorogenic setting where sediment is derived from the erosion of uplifted cordilleras to the rear of zones of deposition also was typical of Alpine Flysch sedimentation.

Do these ponded sediment present the typical characteristics of flysch ? New data available include remarkably high resolution (3.5kz) subbottom profiles that show thin individual strata in the upper 30 to 60 m. of section. Cores of the upper 5 to 10 m. section reveal the petrologic nature of the reflectors: a sequence of thin sand turbidites and laminated and homogeneous muds. Sedimentation has been influenced largely by fluvial input, bypassing of narrow shelves, and transport down steep margins via canyons to basin and trench plains. Profilers and cores reveal typical base-of-slope sequences including tubidites and slumps, and of strata offset by contemporaneous faulting and folding. Intense earthquake activity coupled with relatively small size and topographic isolation of trenches and basin plains has resulted in high rates of sediment ponding. The origin and dispersal paths of clays is unknown, but presumably involve both downslope gravity-induced flow as well as suspension of circulating water masses. The predominance of clay over sand results in a'flysch marneux' facies, not unlike Studer's original Flysch in the Simmental. In contrast, the sand-enriched facies south of the Mediterranean Ridge, derived from North African sources and especially the Nile, more closely resemble the coarser Tertiary 'flysch gréseux' (Macigno, Annot Sandstone, Nummidian, etc) exposed in the circum-Mediterranean.

Interventions à la suite du 7-4

FABRICIUS - Did you find any indication of an origin of quartz sand coming from the shelf of North Africa, as for instance a mixture with shallow water bioclasts ?

Answer : I suppose you speak about the abyssal plain. We have no core from these points.

RYAN -In response to the question of FABRICIUS there are shallow-water detritus from the African margin as significant sedimentary components in sand-silt-clay layers in the Scythe and Herodotus abyssal Plains, such as oolites, rounded quartz, glauconite, as well as pollens and diatoms of estuarine environments.

TABORIN - Rappelle les résultats des campagnes Flexotir du Golfe de Gascogne qui ont mis en évidence une épaisse série litée de turbidites mio-pliocènes dans la plaine abyssale et demande si celles-ci peuvent être assimilées à un flysch. Si de façon plus générale les turbidites ont des caractéristiques de flysch dans des conditions de dépôt souvent différentes.

Réponse : C'est une question de sémantique : si on appelle flysch des dépôts profonds et actifs, alors ce sont des flyschs. Pour moi j'hésite pour l'instant. Est-on en relation avec les déformations alpines ? on penserait à un secteur de compression alors que le Golfe de Gascogne serait plutôt en distension.

NESTEROFF W.D. - Ce qui caractérise d'abord les flyschs c'est le fait qu'ils ont été déposés par des courants de turbidité. Ce sont des turbidites. Leur liaison avec la tectonique n'intervient qu'ensuite. En effet il y a souvent des relations : surrection tectonique - production des turbidites liées à l'érosion qui suit et accompagne les surrections.

Toutefois des turbidites se rencontrent actuellement à toutes les profondeurs dans de nombreuses dispositions morphologiques (marges, plaines abyssales, lacs, etc...) et en relation avec la tectonique locale. Il n'y a pas de type unique de turbidites.

Il s'agit donc d'un problème de sémantique. Faut-il réserver le terme de flysch à certaines turbidites et dans ce cas auxquelles? Le problème reste ouvert.

BYRAMJEE R. - Il faudrait préciser la signification du mot "flysch", parceque sans cela on peut dire qu'il y a eu du flysch presque partout dans les mers et océans. Ce qui me semble déterminant c'est la présence d'une zone mobile et de reliefs suffisant pour permettre un apport massif de sédiments.

Réponse : Tout à fait d'accord. On doit pouvoir distinguer des types de flysch liés à la compression ou à la distension. Ne faut-il pas en effet aller plus loin à l'heure actuelle ?