

**SEISMIC STRATIGRAPHIC AND SEDIMENTOLOGICAL
ANALYSIS OF NEOGENE DELTA FEATURES IN THE
PANNONIAN BASIN**

by

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On the basis of seismic stratigraphy, seismic faciology and sedimentology the Upper Miocene—Pliocene delta formations have decisive role in the Neogene infilling of the Pannonian basin. Delta features can be identified in the Great Hungarian Plain in SW Hungary (Zala and Dráva basin) and in the Little Hungarian Plain (Fig. 1).

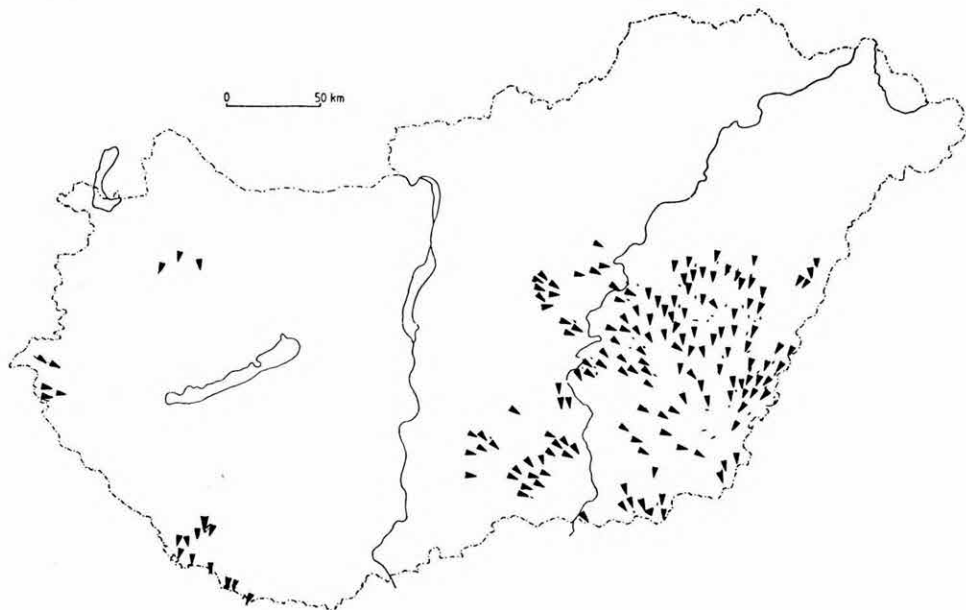


Fig. 1. Distribution of dip direction vectors of the prograding deltaic sequences

Fig. 6 presents the seismic, lithogenetic and lithostratigraphic units of the Great Hungarian Plain. Parts of the delta sequence are marked. On the Fig. 2 can be seen the idealized depositional feature of a delta body and the connected turbidite sequence after BERG (1983).

The delta sequence (illustrated by dip-oriented seismic profile on Fig. 3) represented by characteristic oblique progradational and sigmoid progradational seismic facies implies special depositional conditions, i.e. combinations of relatively high sediment supply, slow to no basin subsidence and a stillstand of the sea level which allows rapid

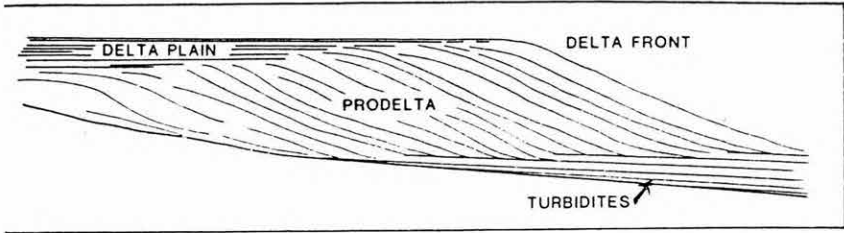


Fig. 2. Model of a prograded fluvial-dominated delta and associated turbidite sequence

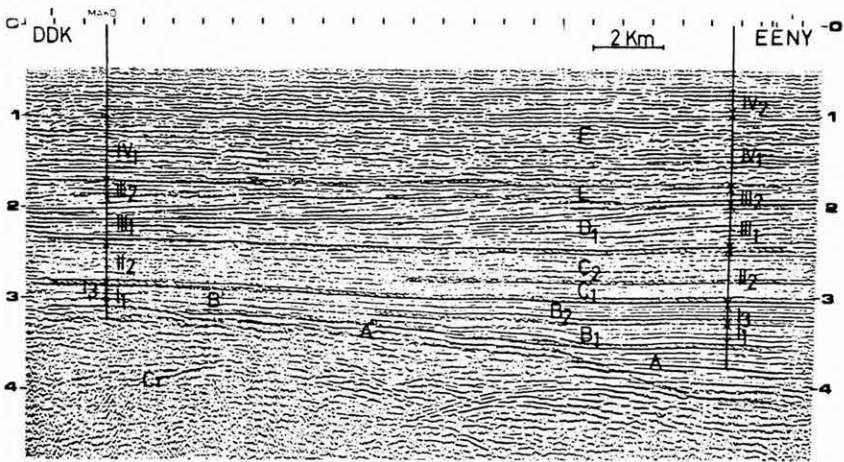


Fig. 3.

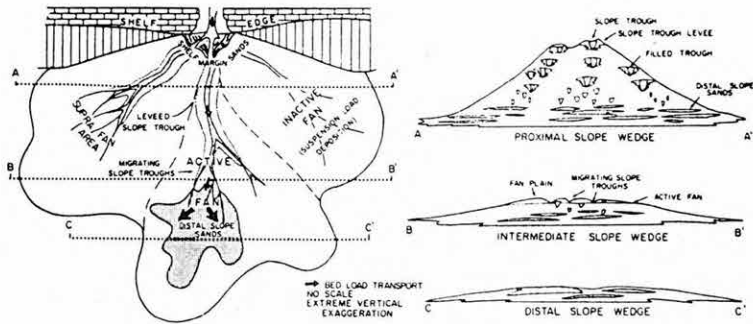


Fig. 4. Slope fan model

basin filling and sedimentary bypass of the upper depositional surface. The strike oriented sections of the delta fans can be seen of Fig. 4 (after BROWN and FISCHER, 1977).

Deposition of sediments prograded gradually from the marginal part of the basin one towards the central, thus the delta formations are the youngest in the central parts of the basin (SE Hungary).

The seismic reflections within the lowest Pannonian depositional sequence (Fig. 5, D—E) indicate that these sediments lie unconformably on the pre-Tertiary basement (showing onlap and downlap structures) and may lie either conformably or unconformably on the older Miocene formations. Reflectors within the sequence are parallel or slightly divergent due to differential subsidence of the basement. This sequence can often be divided into two seismic facies, B and C, characterized by different intensity and continuity of reflectors, and can further be subdivided into several vertically and laterally interfingering seismic subfacies.

The lowermost member of the delta sequence is the Vásárhely Formation (seismic unit B₁) characterized by great amplitude and strong continuity of seismic reflections (Fig. 5, B—C) and by pelitic, pelitic—carbonatic sediments with thin sandstone intercalations. The presence of Bouma sequence in the formation can be recognized. The microfaults and folded-layered structures referring to sediment slides are characteristic. The quiet aquatic sedimentation is dissected by the deposition of the thinning margins of distal turbidites caused by gravitational flows from the shore. This section of the sequence can be interpreted as a prodelta sequence belonging to the delta front. This formation is characteristic first of all in Southeast Hungary.

A sedimentary sequence with similar sedimentation mechanism is found in the central and northern parts of the Great Plain (Nagykőrű Claymarl Formation, seismic unit C₁), the only difference being the higher carbonate and correspondingly the lower sandstone proportions.

The Szolnok Sandstone Formation (seismic unit C₂) is found also in the deeper basin parts, that can be assigned also to the prodelta formations of the delta front and characterized by distal turbidites consisting mainly of argillaceous marl and siltstone and containing more sandstone than the formations above. Above the basement ridges this formation is wedged. Small bioturbations convolutions and siltstone intraclasts also occur here in addition to the Bouma sequences. On the jointing planes flute clasts abound; the plant remnants are also common. In sandstones plates of tenth of millimeter thickness consisting of mica and coalified plant remnants can be observed. In harmony with the electrofacies, these features refer to sandy, silty, gravitational re-deposition, with thinner strata characteristic of distal turbidites and with normal gradation occasionally with bioturbated pelites separating the turbidite bodies.

The areas subsiding most rapidly in early Pannonian time can be identified by increased sediment thickness and by the greater difference in character of the seismic facies B and C.

The Algyó Formation (seismic unit D) consists of several seismic subfacies which grade vertically and horizontally into each other referring to the deposition conditions of delta slope. The most characteristic of these can be correlated with the oblique progradational and sigmoid progradational seismic facies. These formations were observed first by KILÉNYI and RÁKÓCZY (1966) on reflection profiles.

The oblique and sigmoid progradational sequences are characterized by downlapping reflectors at their base, representing the development of sediments from relatively shallow water into deep water. Thinning of the outer toes of individual beds, if present, is beyond seismic resolution. The upper part of this sequence consists of sedimentary rocks deposited by a fluvio-marine system.

The sequence is characterized by thicker sandstone strata belonging to proximal turbidites, by quiet-aquatic argillaceous marl and siltstone strata. Based on rock

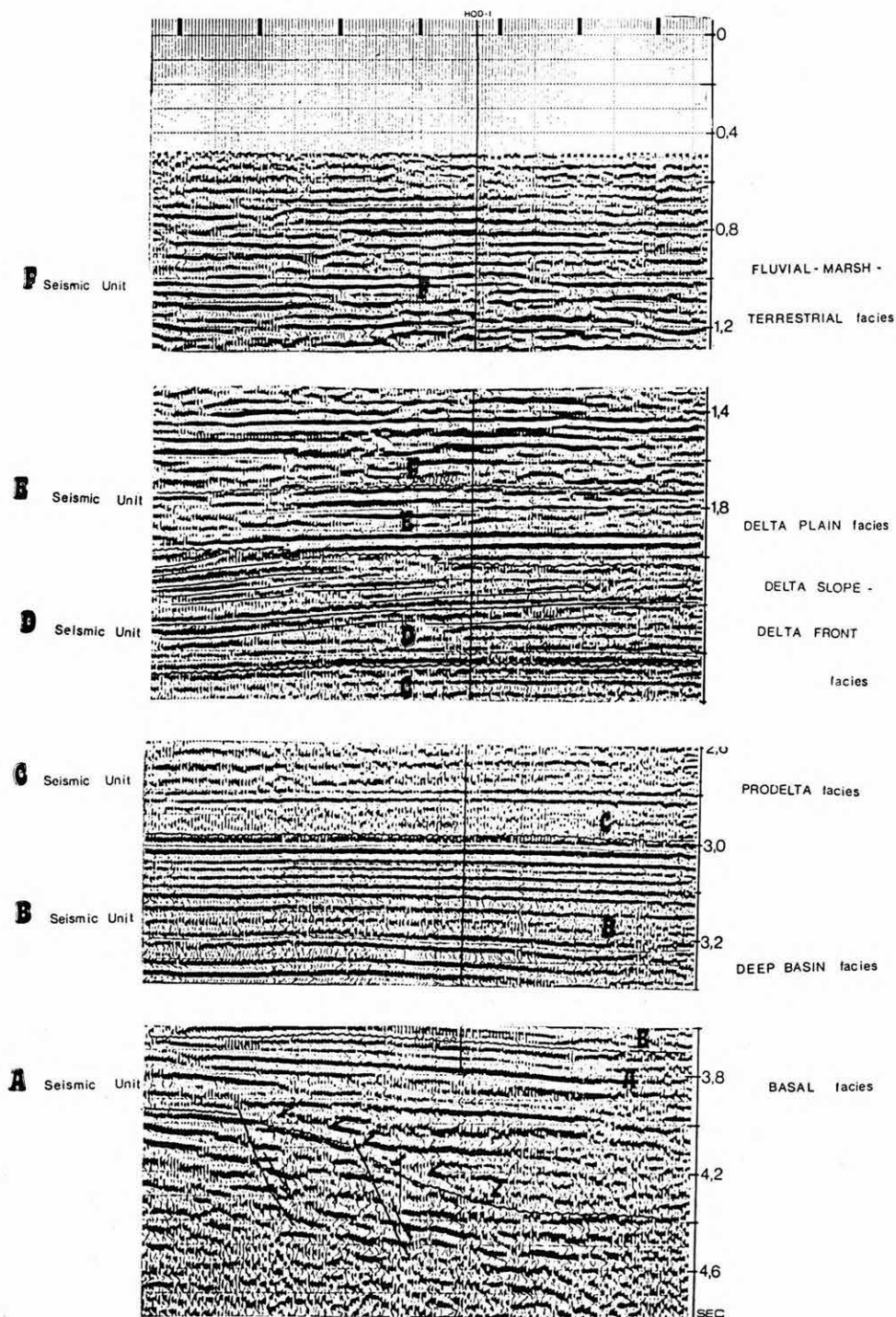


Fig. 5.

SEISMIC FACIES	LITHOGENETIC UNITS	LITHOSTRATIGRAPHIC UNITS		
		FORMATION GROUP	FORMATION	
F	Pa ₂	HEVES IV	Nagyalföld Clay Formation	Fluviatile-lacustrine
E		Pa ₁ ²	CSOMGRÁD III	
D	Pa ₁ ¹			MISKUNCSAP II
C		Pa ₁ ^{1b}	MAROS I	
B	Pa ₁ ^{1a}			MAROS I
		MAROS I	MAROS I	
A	-			MIOCENE
		Cr	-	
			Dorozsma Marl F.	
				Basal facies

Fig. 6. Correlation table of seismic facies and lithostratigraphic units

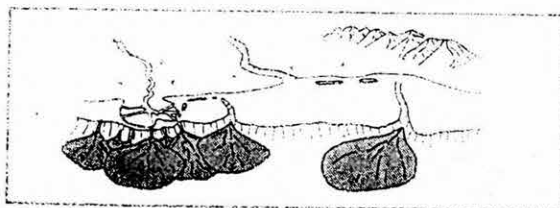


Fig. 7.

structural features all the types of gravitational sediment transport can be presumed. In well log profiles subaquatic beds, mouth bars can be distinguished. The upward coarsening sandstone microrhythms and red colour appearing in the upper section of the formation refer already to the margin of the delta front.

The vertical distance between the lowest and the highest points of the seismic reflections belonging to unit D may reach 700–900 m showing the maximum water depth during the deposition of this unit.

The up-to-date seismic reflection profiles of the Geophysical Exploration Company provided the possibility to study the characteristics of the seismic facies, the dipping conditions, and the spatial distributions of the prograding sequences.

At some hundred points on the basis of two intersecting seismic profiles, the true directions and dip angle of the reflecting surfaces belonging to unit D were determined. Fig. 1 shows the distribution map of the "dip vectors" obtained in this manner. At some points the dip directions of the reflecting surfaces lying over each other were also determined. These results may be seen in Fig. 8 (numbering of the dip vectors assigned to the reflecting surfaces starts from the bottom). The scattering of the dip

directions determined at the same locations refers to the fact that the palaeo-slope conditions had changed rapidly as well as the transport direction in the course of the deposition of the unit. D. Fig. 7 reproduced from BERG (1983) illustrates the palaeogeographic environment during the deposition of unit D.

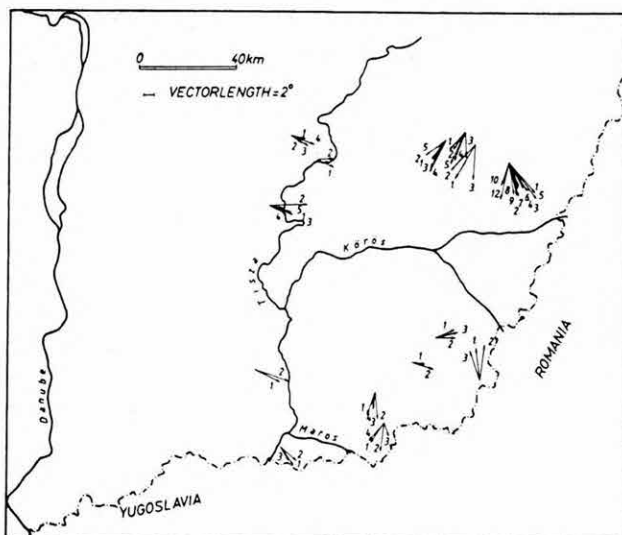


Fig. 8. Dip directions of the reflectors lying over each other in delta sequences (after LUKÁCS et al. 1983)

Unit D is overlain by Törtel Sandstone Formation (unit E) which, in some depressions, consists of two subunits, E_1 and E_2 , and is characterized by parallel onlapping and downlapping reflectors. E_1 is characterized by high amplitude and strong continuity, the overlying E_2 unit by medium to low amplitude and medium to weak continuity. The upper boundary of the unit is conformable with internal reflections. Unit E represents the delta plain facies composed of alternating horizontally bedding sandstone—siltstone and argillaceous marl. Unit E may be interpreted as the partly contemporaneous facies (off-shore and lagoonal) of the prograding unit D. These shallow water formations consist of alternating sequences of lagoonal or terrestrial formations and fluvial sediments deposited in high and low depositional energy conditions.

In this formation the sand content of the sequence suddenly increases. The upward coarsening sedimentary rhythms become predominating. Woody lignite and coaly clay lenses also occur. Both the rock texture and structure, together with the marks cited above refer to the near-shore part of the delta front and the coastal zone of the delta plain as depositional environment. In the hydrocarbon exploration practice the lower boundary of this formation is used as the boundary between the Lower and Upper Pannonian. This, however, does not mean a temporal boundary, it rather follows the temporally long-lasting process of the progradation of the delta front-coastal environment, that is of an event of filling starting from the basin margins.

The third and shallowest depositional sequence the Zagyva Formation (unit F) makes up the youngest member of the Pannonian formations. In certain regions (e.g.

Danube—Rába lowland, the north Jász region, the foreground of the Mátra Mts, the southern part of the Derecske depression) an unconformity within the Upper Pannonian sequence could be identified seismically (see POGÁCSÁS in this volume). The Unit F is characterized by parallel and slightly divergent reflectors, with low to moderate continuity and moderate to high intensity (Fig. 5, F). The seismic and sedimentary characteristics of unit F (Zagyva Formation) suggest fluvial, flood-plain, marshy, terrestrial and lacustrine sedimentation. The Nagyalföld Clay Formation containing variegated clays and fluvial sand is the final member of the Pannonian sedimentation.

The sequence introduced above from the bottom towards the top indicates simultaneously the migration of the shore-line and it reflects fairly well both the temporal succession and the lateral contemporaneity of the facies, respectively.

Summarizing one can conclude that in the Neogene the Hungarian part of the Pannonian basin was filled up by sediments of prograding delta systems and connected environments from the margins of the basin (Fig. 1). The Great Hungarian Plain was filled from northwest and north east direction, the Zala basin from northwest and the Dráva basin from north.

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