

THICKNESS OF THE GANGETIC ALLUVIUM NEAR CALCUTTA AS DEDUCED FROM REFLECTION SEISMIC MEASUREMENTS*

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THE alluvial tract in the Ganges Delta has of late received considerable attention and publicity, particularly in regard to the possibilities of occurrence of petroleum in the rocks underlying the alluvium. The Ganges Delta, as is the case with the rest of the vast Indo-Gangetic Plain, is known to be covered by a thick mantle of alluvium. The Indo-Gangetic alluvial tract is believed to be a synclinal basin, the age of this depression being Upper Eocene, though its maximum development is believed to have occurred during Middle Miocene times. The depth of alluvium in this basin is presumed to be maximum on its northern margins, the floor of the basin rising steadily towards the south as it shelves up towards the mass of the Indian Peninsula. Geodetic data seem to indicate a maximum thickness of the order of 6,500' for the alluvium in Bihar.

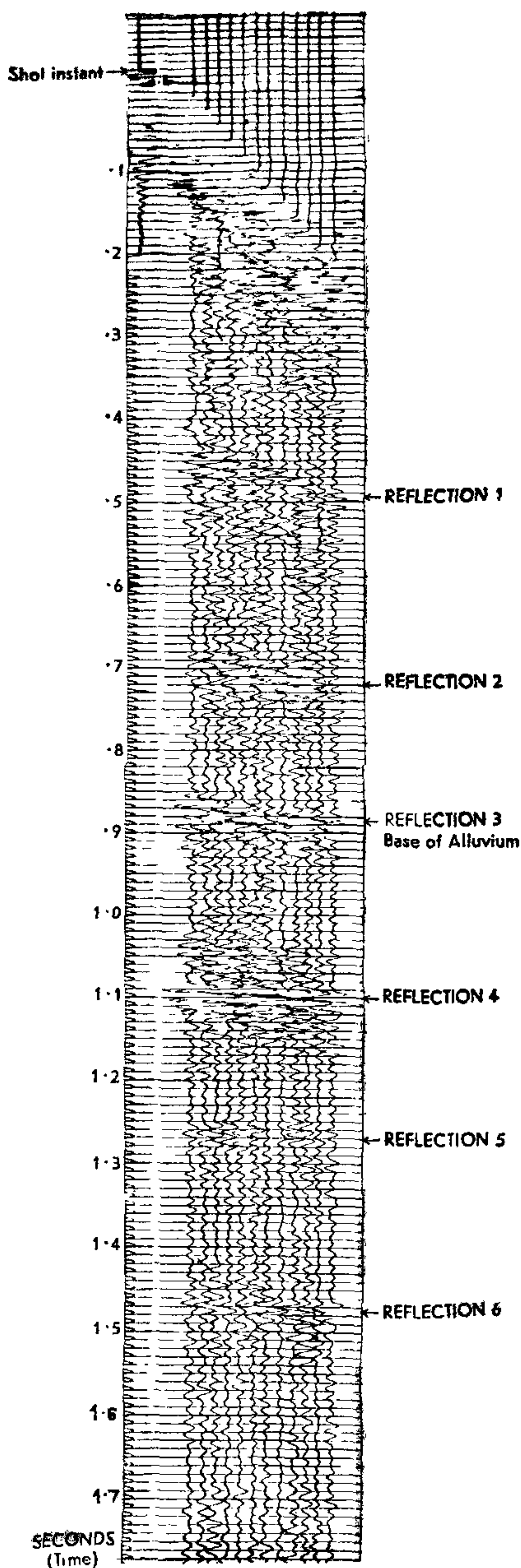
The existence of some major and minor 'up-warps' and 'downwarps' has been postulated by Glennie^{1,7} to explain some of the observed geodetic anomalies. He has suggested a crest line under the Gangetic alluvium north of Calcutta sweeping around as a great arc between Allahabad and Banaras extending to Shillong. He believes a minor downwarp to occur as another sweeping arc in a north to south direction through Jalpaiguri and extending southwest to Dhulian, but suggests no downwarp through or near the Ganges Delta. Fox believes that the Ganges-Brahmaputra Delta is a "tectonic downwarp produced by the thrust from the Burma, Hill Tippera and Assam range direction westward towards the Bihar Plateau". The alluvium is believed to be shallow between the Rajmahal and Garo Hills which are apparently connected by an underground ridge. Glennie has stated that the Gangetic trough of Bihar and the United Provinces does not extend below the Delta into the Bay of Bengal. A glance at the Geological Map of India shows the presence of the Durgapur beds believed to be of Supra-Panchet age cropping out near the Damodar River to the north-west of Calcutta while immediately to the south and south-west of the Durgapur beds lie the igneous and metamorphic rocks interposed by the Lower Gondwana formations. On the eastern side of the Delta, to the east of the Megna River are the undifferentiated Tertiaries. What lies underneath the

alluvium in between is a matter for speculation. No marine shells have been discovered in the alluvial deposits of the Delta. A number of tube wells have been sunk in and near Calcutta during the past 100 years or more, for purposes of ground water-supply and the deepest of these is the Akra Road well sunk in Garden Reach near Calcutta and taken to a depth of 1,306' without reaching the base of the alluvium. The bore hole log for this well revealed several alternations of clay, sand of varying texture, kankar and pebble beds and also a bed of sandstone and clay of 6½' in thickness at a depth of 1,017'.

The author recently carried out some Reflection Seismic measurements in the Sodepur (22° 42' N; 88° 23' E)-Madhyamgram (22° 41' N, 88° 28' E)-Barasat (22° 43' N; 88° 29' E) area in the 24 Parganas near Calcutta on an experimental basis to test whether the method can be used with advantage in this area for exploration purposes and to study the seismic characteristics of the area, i.e., the probable distribution of average velocity with depth, the quality and number of seismic reflections, etc. A modern portable 24-channel reflection seismic equipment manufactured by Messrs Technical Instrument Co., Houston, U.S.A., was used. Charges of 2 lb and occasionally more of explosives were used in shot holes at depths of 10-16' from the ground surface. Fortunately, such shallow shot holes and small charges proved sufficient as the water table in this area lies at quite small depths varying from 10-20'. The 'split-spread' arrangement of shot-point and detectors was employed following the continuous profiling method. Observations were made along two profiles, one in an approximately east-west direction running from Sodepur to Madhyamgram and the other in a NNE direction from Madhyamgram to Barasat and beyond obtaining in all over 100 records. Generally six well-defined 'reflections' were recorded in the seismograms. A specimen record obtained along the Madhyamgram-Barasat highway is reproduced below:

Of these, the third, fourth and fifth reflections were found to be the most consistent. Reflection 6 has not been always recorded. This could reasonably be attributed to the fact that sufficient energy could not always be impressed to the deeper horizons owing to the shallow nature of the shot holes and the small quantities of charge used. Deeper shot-holes could not be drilled owing to the lack of a regular

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seismic shot-hole drilling equipment. Normally, one would expect that the first of the recorded reflections would represent the base of the alluvium which is a discontinuity of marked geological and seismic contrast and should, therefore, provide clear and strong reflections. An analysis of all the seismograms shows that the first two reflections, in addition to the erratic nature of their arrival times, are neither so clear nor so pronounced as the third and the later ones. Again the computed depth to the first reflection is only of 1,000' whereas it is known from the results of the Akra well that the alluvium is thicker than 1,300'. The second reflection occurs at depths varying between 1,500-2,200' and as pointed out are quite erratic. Also, the arrival times for the first two reflections do not tally on the east-west and north-south profiles whereas those for the later reflections do. For these reasons it seems reasonable to infer that the third reflection represents the base of the alluvium in this area, the thickness of which would then vary within a range of 2,500-3,000'. The first two reflections will then have to be attributed to some inter-alluvial phases which act as reflecting horizons. The existence of such phases is quite likely and understandable, when we bear in mind that the alluvium is not at all homogeneous in depth as shown by the results of the Akra Road well which for instance, as has already been pointed out, revealed the existence of a sandstone bed of 6½' in thickness at a depth of 1,017'. It also seems reasonable to infer that the reflecting horizons represented by reflections later than the third are the interfaces of consolidated sedimentary rocks beneath the alluvium. This is indicated from a study of the variation of average velocity with depth.

The alluvial area seems well suited for the application of the Reflection Seismic Method and useful indications of the structure of the underlying formations may be obtained as an aid for oil exploration.

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2. Oldham, R. D., "The Indo-Gangetic Plain" *Manual of the Geology of India*, 2nd Ed., 1893, 427-58.
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5. —, *Ibid.*, 1937, 24.
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