

## AN EXAMPLE OF EXTRUSION OF FLUID MUD THROUGH MUDCRACKS AND AN ORIGIN OF SEDIMENT DIKES<sup>1</sup>

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### ABSTRACT

Wells, N. A. & M. A. Jah 1982 An example of extrusion of fluid mud through mudcracks and an origin of sedimentary dikes – Geol. Mijnbouw 61: 401-402.

Wrinkles of mud forming a mudcrack-like pattern across the top of a small mud-filled depression are explained as the result of extrusion of slightly overpressured underlying fluid mud. On a small scale, this confirms a mode of formation of soft-sediment dikes hypothesized by Oomkens (1966).

The purpose of this note is to record the formation of mud ridges on drying mud (Fig. 1) and to confirm a mode of origin of formation of soft-sediment dikes hypothesized by OOMKENS (1966). The mud surface has been wrinkled into unusual raised features that show an everted but otherwise common mudcrack pattern. The wrinkles, or ridges, are thin and 1 to 6 mm high. They were found on 28 November 1980 thirty-six hours after a heavy night rain, in Teri Toi (Teri River) in the Kohat District of north-central Pakistan (Fig. 2). Teri Toi is a perennial but decidedly "flashy" small river. Its streamcourse, which is incised in sandstones, shales, and alluvium, is 100 to 200 m wide. Bedforms, mostly side bars and sand waves (*sensu* COLLINSON, 1978, p. 26), are predominantly formed at high stage and are not reworked later. At low water, flow may be reduced to a steady trickle between pools that are generally 5 to 10 m across and 20 to 40 cm deep (a few are as deep as 1.5 m). The flood that deposited the mud under discussion apparently crested about 0.5 m above low water. The preceding storm had been the first in several weeks. Between the storm and the discovery of the mud ridges, the days had been typically warm (estimated 21°-25°C) and almost entirely cloud-free.

The depression in which the mud ridges formed was situated on a sand flat among boulders between a relatively deep pool in the river and a clay cliff. The belt of sand and boulders was narrower than 3 m and the depression was less than a metre in diameter and 5-10 cm deep, after filling. The depression and the sand flat were coated with about 10-15 cm of mud. The depression was perched 30-35 cm above the river

channel and was apparently shaded much of the day. The mud had neither drained nor dried much when discovered, for its surface was still sticky and the mud a centimetre or two below was still very wet. In contrast, exposed mud on gravel bars had formed bone-dry and brittle flakes.

The ridges were formed in the mud and of the mud. By field estimate, the mud was mostly clay with a slight amount of silt. Its mineralogy is not known. No decomposition gases, which might cause extrusion of mud, could be detected, and no internal structure could be seen in small trenches cut into the wet mud. No springs were found in the immediate area. Much gypsum and salt crops out in the valley, but no evaporites could be seen or tasted within the mud. A very small amount of gypsum had precipitated as thin efflorescent traces around nearby boulders and in depressions, however. Drying of the mud, without considerable compaction or pore filling, seems unlikely to have made the thin and still slightly moist surface dense enough to sink into the underlying wet mud (consider, for instance, that a water-saturated kaolinite mud will become lighter on drying to 5% pore-water unless total porosity is decreased by about a third; mud originally with 50% pore-water and no air has the same density as drier mud with 5% water and 28% air, and mud originally with 20% water equals mud with 5% water and 9% air; assuming the density of kaolinite = 2.63 g/cm<sup>3</sup>).

The most reasonable explanation for the origin of these everted mudcracks is that the pressure of fluid mud oozing into the depression below a crust of drier mud extruded fluid mud through the mudcracks as they formed. The everted mudcracks are therefore interpreted as small mudcrack-controlled soft-sediment dikes.

OOMKENS (1966) hypothesized that sand dikes could form 1) when a hard and impermeable thin surface cracks from desiccation and less dense and water-saturated mud flows up from below, 2) when pore pressure in subsurface fluid muds is

<sup>1</sup>Manuscript received: 1982-02-03.

Revised manuscript accepted: 1982-07-09.

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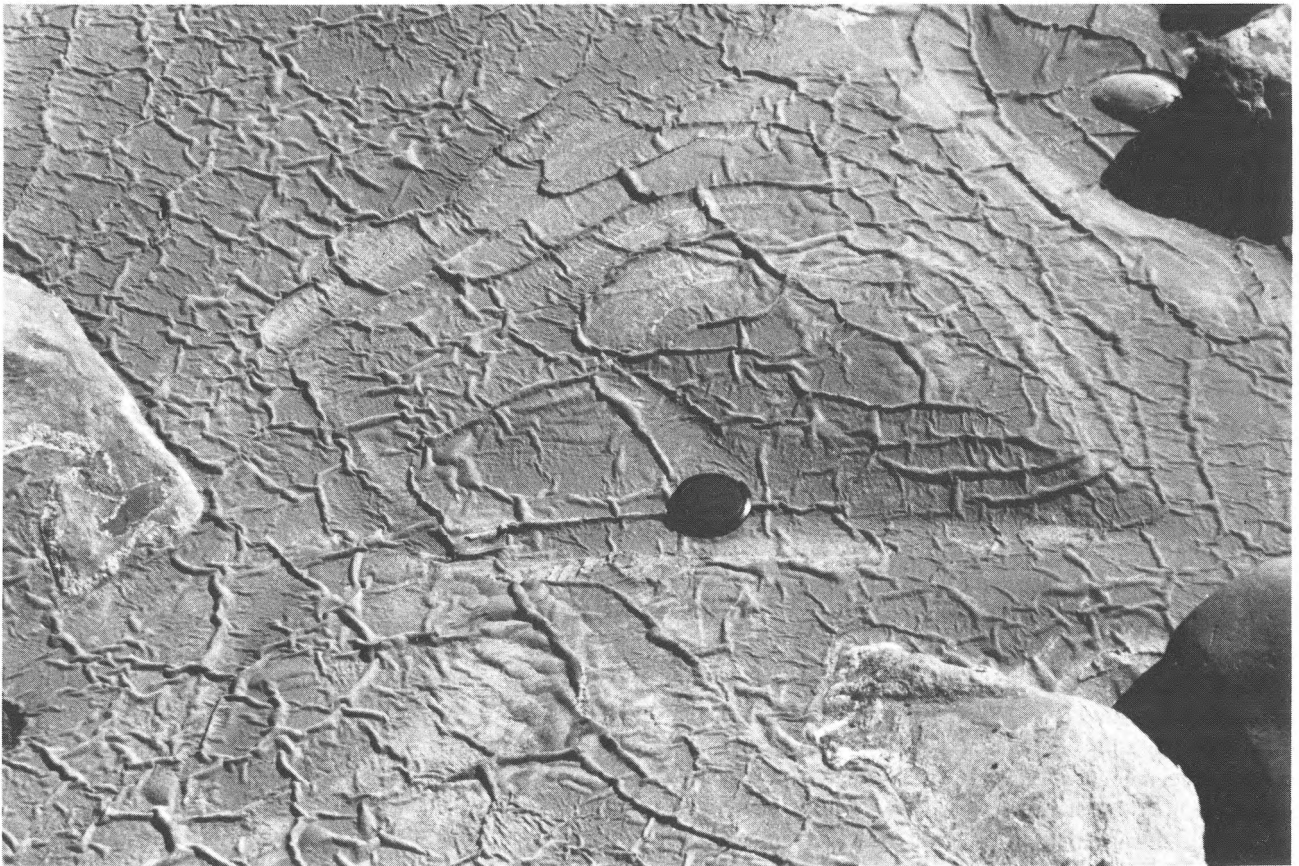


Fig. 1. A small pocket of wrinkled damp mud. Hydrostatic pressure below the centre of the depression is believed to have been increased sufficiently by wet mud flowing into the depression beneath a relatively dry crust to extrude the wet mud through newly opened mudcracks across the centre of the depression. Note the influence on the mudcrack pattern of the bulge over a boulder buried in the centre of the depression. The camera lens cap has a diameter of 52 mm.

increased sufficiently to cause its injection upward through weak points in a rigid overlying crust, 3) by loading of the surface by migration of sand dunes, 4) by slow downslope flow of subsurface muds into the centre of a depression, 5) through earthquakes, which can crack the hard surface as well as increase pore pressure, and 6) by large changes in atmospher-

ic pressure during major storms. He cited examples of the first, fifth, and sixth mechanisms. His fourth possible mode of formation is convincingly demonstrated, on a small scale at least, by the everted mudcracks reported above.

Lastly, these features are of interest to field geologists because they might be mistaken for overturned mudcracks in the absence of other geopetal indicators.

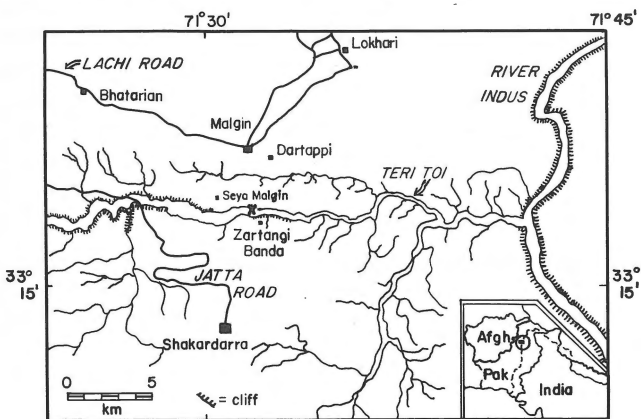


Fig. 2. The mud wrinkles were found on the north side of Teri Toi at the spot marked X between Seya Malgin and Zertangi Banda in the middle of the map. The circled solid rectangle in the map inserted at lower right locates the study area.

ACKNOWLEDGEMENTS

These features were found during research sponsored by the Geological Survey of Pakistan and by the Smithsonian Institution Foreign Currency Program (Grant SFC-00845700 to Dr. Philip D. Gingerich). Ms. Caren Cercone and Dr. Gingerich reviewed drafts of this manuscript.

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