Armoured mud balls revisited

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Armoured mud balls ranging in size from 2 to 20 cm in diameter (long axis) are common in the upper intertidal zone around Swan Creek, near Parrsboro, on the north shore of the Minas Basin. Shapes vary from nearly spherical to platy to elongate, with elongate predominant. The mud balls form from the action of wave and tidal currents transporting eroded masses of clay, as evidenced by the strike- and dip-parallel orientations of the mud balls with respect to the shore.

Les pelotes de vase blindées d'une taille de 2 à 20 cm de diamètre (axe longitudinal) sont répandues dans la zone intertidale supérieure voisine de Swan Creek, près de Parrsboro, sur la rive nord du bassin Minas. Leur forme varie des pelotes quasi sphériques à celles aplaties et allongées, les pelotes allongées étant néanmoins prédominantes. Les pelotes de vase se forment par l'action des vagues et des courants de marée transportant des masses érodées d'argile, comme en font foi les orientations parallèles aux couches et aux inclinaisons magnétiques des pelotes de vase par rapport au rivage.

[Traduit par la rédaction]

Introduction

Armoured mud balls, that consist of rounded, pebble-encrusted masses of clay, are unusual clastic sedimentary structures observed primarily in fluvial and tidal settings. Their origin in fluvial environments, in which downstream transport of clay masses produces a nearly spherical shape, has been long recognized (Haas, 1927; Bell, 1940; Pettijohn and Potter, 1964). Additionally, their origin has been documented on shorelines of lacustrine (Haas, 1927; Dickas and Lunking, 1968) and marine environments (Grabau, 1932; Kugler and Saunders, 1959; Hall and Fritz, 1984) where oscillatory motion from wave action produces more elongate shapes. The occurrence of armoured mud balls in the intertidal zone of megatidal coasts has been reported by Thompson (1968) and Stanley (1969). Armoured mud balls in the intertidal zone of the Minas Basin (near Lower Five Islands) have been described by Stanley (1969) who observed the following: (1) a tendency toward bladed and elongate shapes for the mud balls; (2) a tendency for roundness of the mud balls to increase with distance from the high tide mark; and (3) a preferred orientation of the long axes of mud balls parallel to the shoreline. Reports of the occurrence of armoured mud balls in ancient settings are few, although armoured mud balls of Jurassic age have been described in alluvial fan deposits of the Deerfield basin (Little, 1982).

Observations

Armoured mud balls were observed on the north shore of the Minas Basin near the town of Parrsboro on a 50 m long section of beach immediately to the east of Swan Creek, and on a 100 m long section of beach to the west of the creek (Fig. 1). This area is about 11 km west of the area studied by Stanley (1969). The mud balls are found on the upper part of the intertidal zone, in an area where the beach is veneered by pebbly sand, from an elevation just below the high tide mark (in a 10 m tidal range) to the edge of the intertidal mudflat. The armoured nature of the mudballs was easily confirmed by slicing several open. The interior of each mud ball consists of massive clay and the exterior is uniformly coated by a layer of sand to pebble-size clasts up to 25 mm in diameter.

Based on 50 measurements, the mud balls range in size from 2 to 20 cm in diameter (long axis) with a mean diameter of 9 cm. The shapes of these objects are variable and include nearly spherical (compact by the method of Sneed and Folk, 1958), prolate spheroid (platy of Sneed and Folk) (Fig. 2a), and oblate spheroid shapes (elongate of Sneed and Folk) (Fig. 2a, b), the last being the most abundant. The concentration of mud balls averages 0.5 per m^2 across the area in which they occur; however, the distribution of mud balls within this area is irregular.

No clear correlation of distance from the high tide mark with size or shape was observed. Elongate mud balls were observed lying in orientations both parallel to the strike direction of the beach as well as parallel to the dip direction (Fig. 2c). Of 33 elongate mud balls, 15 were dip-oriented, 11 were strike-oriented, and 7 were intermediate. Mud balls with a strike-parallel orientation were observed adjacent to those with a dip-parallel orientation.

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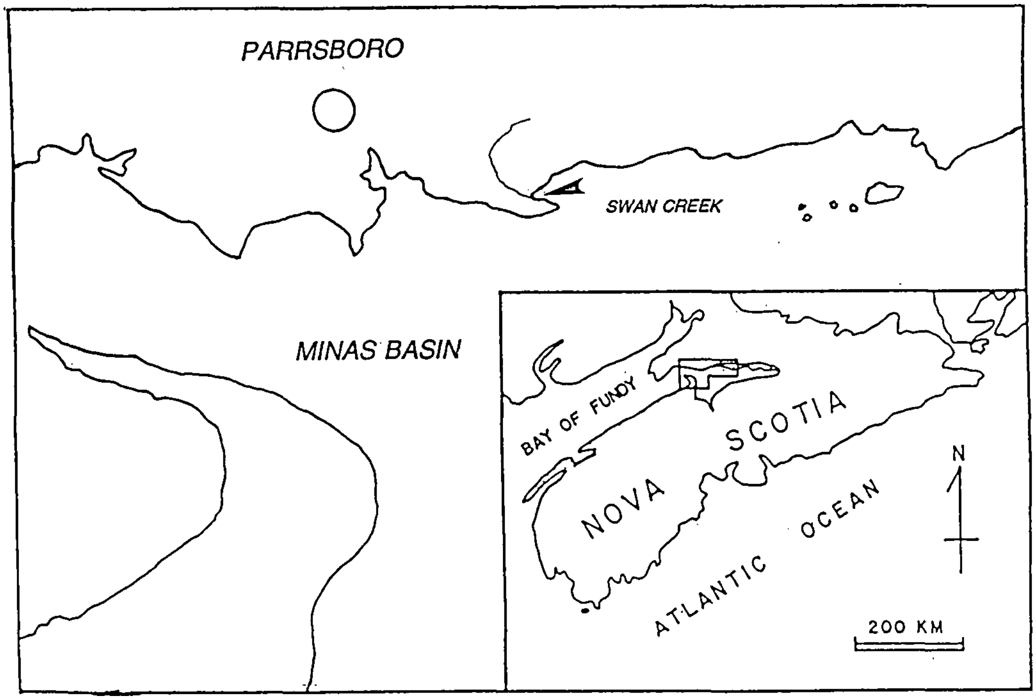
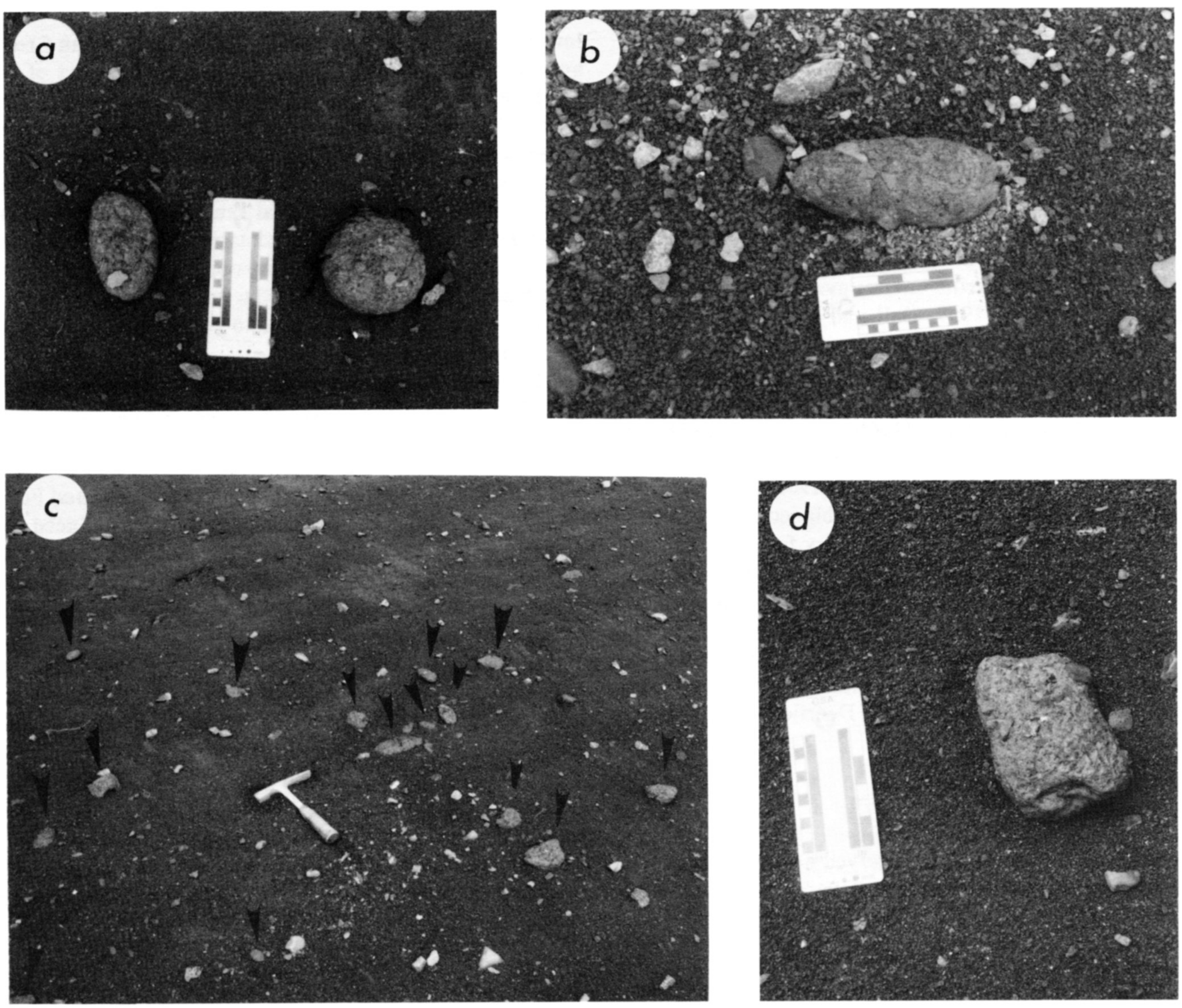


Fig. 1. Location of the study area on the north shore of the Minas Basin. Arrow indicates location of armoured mudball occurrence at the outlet of Swan Creek.



ORIGIN OF THE MUD BALLS

The occurrence of the mud balls coincides with areas in which high tides undercut cliffs of glacially-derived cohesive clay. The resulting slumps are broken into blocks by wave action and subsequently rounded. The compact form of irregularly shaped mud balls (Fig. 2d) suggests an origin as equant blocks prior to undergoing significant rounding. Transport across the pebbly beach causes the armouring by the adherence of coarse sediment that covers the upper intertidal zone. At Swan Creek, this process occurs in a cove which is sheltered and therefore experiences little intense wave activity. During the period of high tide, gently lapping waves roll the lumps up and down the beach, thus resulting in their preferential elongate shape and armouring. If wave activity were solely responsible for movement, a consistent strike-parallel orientation of elongate shapes would be expected. The dip-parallel orientation of a significant number of mud balls indicates transport by tidal currents. Ebb-tidal currents in this area are much stronger than flood-tidal currents and are directed parallel to shore, resulting in the reorientation and transport of many mud balls. A mud ball that has reached this orientation may be resistant to reorientation by gentle wave activity.

DISCUSSION

The findings of this study largely support those of Stanley (1969), differing substantially only in the importance of transport of the mud balls by tidal currents. Reorientation of the clasts by ebb-tidal currents leaves a high proportion in a dip-parallel orientation that may be resistant to change under normal (gentle) wave conditions. Higher energy wave conditions associated with storms or spring tides may cause reorientation of the clasts. Stanley (1969) and Hall and Fritz (1984) address the preservation potential of this feature in the shoreline environment and conclude that this structure is preservable and may be a possible facies indicator.

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BELL, H.S. 1940. Armored mud balls - their origin, properties, and role in sedimentation. Journal of Geology, 48, pp. 1-31.

DICKAS, A.B. and LUNKING, W. 1968. The origin and destruction of armored mud balls in a freshwater lacustrine environment, Lake Superior. Journal of Sedimentary Petrology, 38, pp. 1366-1370.

GRABAU, A.W. 1932. Principles of Stratigraphy, (3rd edition). A.G. Seiler, New York, 1185 p.

HAAS, W.H. 1927. Formation of clay balls. Journal of Geology, 35, pp. 150-157.

HALL, A.M. and FRITZ, W.J. 1984. Armored mud balls from Cabretta and Sapelo Barrier Islands, Georgia. Journal of Sedimentary Petrology, 54, pp. 831-835.

KUGLER, H.G. and SAUNDERS, J.B. 1959. Occurrence of armored mud balls in Trinidad, West Indies. Journal of Geology, 67, pp. 563-565.

LITTLE, R.D. 1982. Lithified armored mud balls of the Lower Jurassic Turners Falls Sandstone, north-central Massachusetts. Journal of Geology, 90, pp. 203-207.

PETTIJOHN, F.J. and POTTER, P.E. 1964. Atlas and Glossary of Primary Sedimentary Structures. New York, Springer-Verlag, 370 p.

SNEED, E.D. and FOLK, R.L. 1958. Pebbles in the lower Colorado River, Texas, a study in particle morphogenesis. Journal of Geology, 66, pp. 114-150.

STANLEY, D.J. 1969. Armored mud balls in an intertidal environment. Journal of Geology, 77, pp. 683-693.

THOMPSON, R.W. 1968. Tidal Flat Sedimentation on the Colorado River Delta, Northwestern Gulf of California. Geological Society of America, Memoir 107, 133 p.

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Fig. 2. (a) Mud balls with platy shape (right) and elongate shape (left) (after Sneed and Folk, 1958). (b) Mud ball with very elongate shape (after Sneed and Folk, 1958). (c) Field with unusually high concentration of armoured mud balls with varying shapes and orientations. Fifteen individual mud balls are identified by arrows. The hammer handle is oriented parallel to the dip of the beach. Elongate-shaped mud balls are visible with dip- and strike-parallel orientations. (d) Compact-bladed form of this irregularly-shaped mud ball indicates relative immaturity.