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DIRECTION OF MOVEMENT OF LATE PALEOZOIC GLACIERS IN ANGOLA (WESTERN AFRICA)

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ABSTRACT

Identification of a boulder pavement intercalated between two diamictites of the "Lutôe Series" in Angola points out for a glacial origin for these rocks.

Measurement of striae on clasts, their disposition in the pavement and the fabric of diamictites indicate movement of Late Paleozoic (Gondwana) glaciers towards NW in this part of the Congo Basin.

RESUMO

A identificação de um pavimento de clastos intercalado entre dois diamictitos da "Série de Lutôe", Angola, constitue evidência de origem glacial dessas rochas.

A orientação de estrias sobre os clastos, a disposição espacial destes no pavimento, e a orientação de clastos de diamictitos indicam que as geleiras neopaleozóicas deslocaram-se de SE–NW nesta parte da Bacia do Congo.

INTRODUCTION

Better knowledge of the nature, facies and distribution of Late Paleozoic glacial deposits of the Angolan part of the Congo Basin (Veatch, 1935) is important in making pre-drif paleogeographic reconstructions of Africa and South America when they were joined. (Frakes et al. 1970; Rocha-Campos, 1972).

The deposits were examined briefly in 1970, and their distribution, stratigraphy, facies, and paleogeography in northeastern Angola were investigated in more detail in April, 1972 and July, 1974, in a joint project with the Instituto de Investigação Científica de Angola.

Discovery of glacial structures described in this report contributes to the understanding of the environment of deposition of Late Paleozoic diamictites of Angola and furnishes important data on the sense of Gondwana glaciers movement.

GEOLOGY

Late Paleozoic glacial deposits of Angola (Western Africa) known as "Lutôe Series"(Mouta, 1954) are developed in two main areas. In the Baixa do Cassanje tectonic basin (Fig. 1) they outcrop extensively along the valleys of the Bali and Lutôe rivers (Mouta, 1954). In the Lunda district the outcrops are less continuous and the rocks occur as narrow strips generally included along tectonic valleys (Real, 1959). (Fig. 1.)

na of fish and conchostracans ("Lower Cassanje Series", Mouta, 1954) considered as of Permian-Triassic affinity (Teixeira, 1948b, 1949).

In the Baixa Cassanje, the Lutôe (up to 50 m thick) consists mainly of red-brick diamictites intercalated with red sandstone, conglomerate, mudstone and shale. At least 3 or 4 diamictite horizons could be recognized in the sections examined. Clasts of varied lithologies occur throughout the sequen-

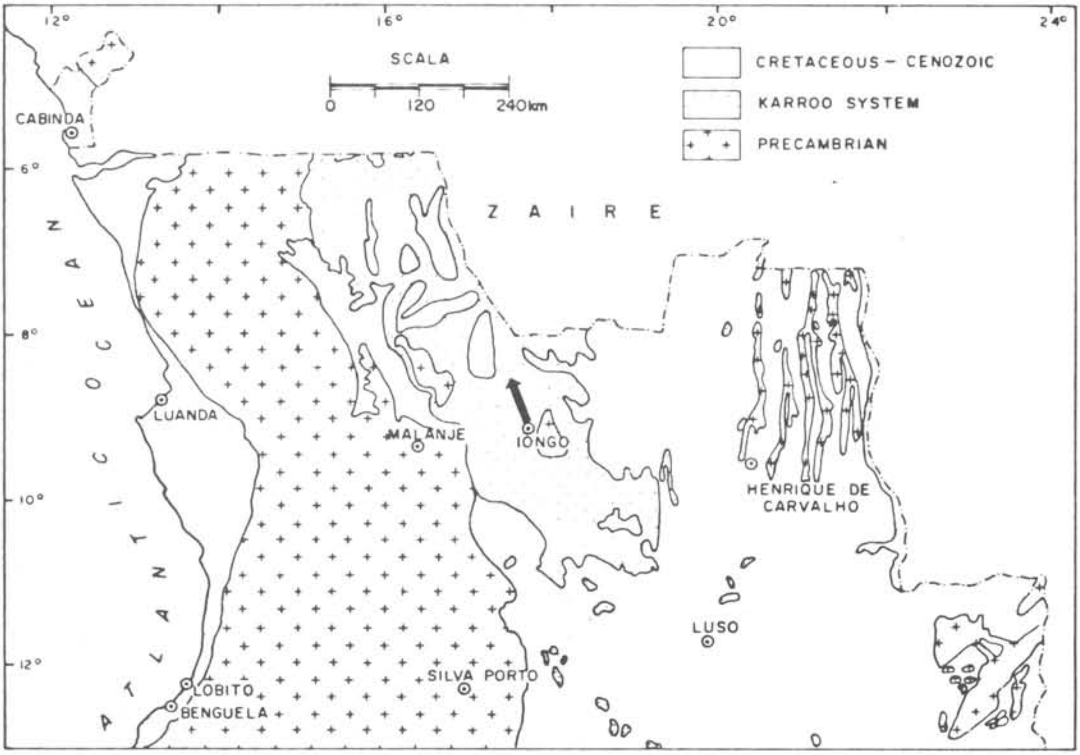

Fig. 1 Locality map showing summarised ice-movement data. (base map by Mouta, 1954)

The age of the sequence within the Late Paleozoic is still undetermined. In the Lunda distric of northeastern Angola the Lutôe contains a fossil flora (Teixeira, 1948 a; Real, 1959) which may indicate and age ranging from Upper Carboniferous to Lower Permian (Rigby, 1973). In the Baixa do Cassanje the Lutôe is transitionally overlain by laminites with a rich and well preserved fau-

ce and may reach maximum diameters of 2 meters. They are composed mainly of granites, gneisses and quarzites of the "Basal Complex", and red arkoses and shales of the "Schisto-Gréseux Series" of the "West Congo System" (Mouta, 1954, Real, 1959; Rocha-Campos, 1972), which form the local basement of Precambrian age.

The diamictites have a clay-rich matrix and are mainly non-stratified. Except for structures described below only small lenticular sandstone interbeds were observed, in a few cases apparently deformed and disrupted (Rocha-Campos, 1972). Interpretation of glacial origin for these rocks has been mainly based on the widespread occurrence of striae on clasts (Mouta, 1954; Real, 1959), of the type generally considered as typically glacial (Wentworth, 1936; Rocha-Campos, 1972).

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DESCRIPTION OF THE BOULDER PAVEMENT LOCALITY

During field work in 1972, a striated boulder pavement was discovered on top of a diamictite layer disconformably overlain by another diamictite bed, outcropping on the right bank of the Bali river, 1.5 km to the northeast of the village of Iongo, on the Iongo-Cuango dirt road (Figs. 2,3). The two superposed diamictites are texturally very similar.

Fig. 3 Detail southeastern extremity of boulder pavement.

The lowermost diamictite oucropping at the Bali river locality contains groupings of clasts oval or V-shaped in section, of more or less defined boundaries. They are similar to others included in Late Paleozoic diamictites in Falkland Islands and Paraná Basin (Frakes et al., 1967; Farjallat, 1970). The V-shaped clast concentrations may correspond to large conglomeratic load-casts (Frakes et alii, 1971). They may, alternatively, correspond to englacial or subglacial channels.

A feature common to both diamictite horizons is the presence of lenticular, tabular and irregularly branched sandstone and and conglomerate bodies which may be horizontal or oblique in orientation (Fig. 2). Some may cut both diamictites across the boulder pavement. These features are geometrically similar to Pleistocene and Recent pseudomorphs of ice-veins or wedges developped in frozen till (Taber, 1929; Schafer, 1949). They may show enlarged areas similar in shape to the clast groupings which nay represent sand and conglomerate filled englacial channels from where dykes and venules radiate. Stratification of sandstone or conglomerate indicates filing probably by melting water. Similar features have also been reported enclosed in Late Paleozoic diamictites of the Paraná Basin, Brazil (Rocha Campos, 1966; Rocha-Campos et alii., 1969). The upper diamictite passes by transition into thick-bedded, red, medium-grained, feldsphatic with dropped clasts.

Clasts of the pavement, lithologically similar to the ones within the diamictite, are discontinuously concentrated along the top of the lower diamictite layer (Fig. 3). Some of them have a plane upper surface bearing striae.

The superposition of the diamictite layers separated by the boulder pavement at Iongo indicates that at least part of Lutôe diamictites were deposited subaereally as tills. These relations also suggest multicyclic glaciation in Angola.

DETERMINATION OF LATE PALEOZOIC GLACIER MOVEMENT

Late Paleozoic ice-movement in the Baixa do Cassanje area in Angola which was towards the northwest (Figs. 1 and 4) was determined from the orientation of striae on the top of clasts of the boulder pavement. At least 6 large clasts bear striae on their upper surface, mostly in a subparallel fashion; only one clast shows two crossed sets. The sense of the movement was based upon up-glacier inclination of upper beveled surface of clasts. Other guidelines, as disposition of plucked ends of clasts, trains of clast fragments (Frakes et alii., 1966) could not be used locally.

Former interpretation of the direction of movement of Late Paleozoic glaciers in Angola was based upon measurement of apparent elongation of large clasts on a bedding plane of a diamictite outcropping a few meters above the present locality. These measurements showed a maximum in the SE–NW direction (Rocha-Campos, 1972) and a sense of movement towards the southeast was derived from primary sedimentary structures of supposedly Lutôe rocks outcroping along the Cuango-Luremo road, about 60 km to the NE of the present locality. These beds have since been reinterpreted as belonging to the "West Çongo System" and so, the interpretation no longer applies.

Orientation of clasts in this and another locality near the Bali river is compared in Fig. 4 with direction of striae on clasts of the boulder pavement. The preferred interpretation of sense of movement is also

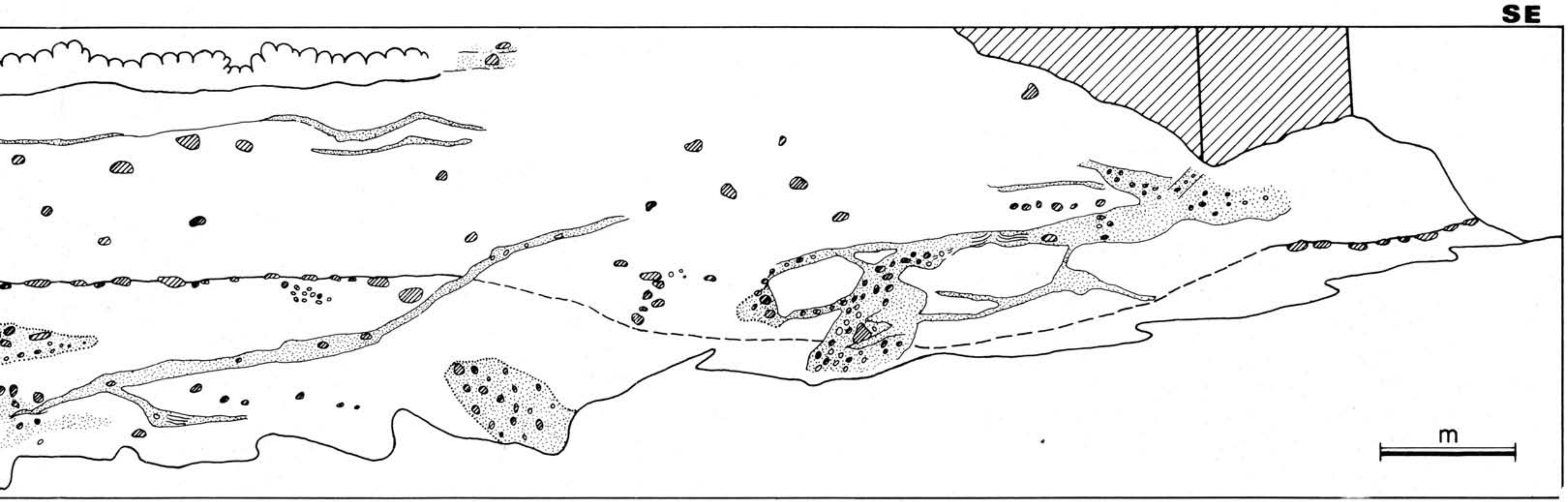

Fig. 2 Diagram of boulder pavement at Bali river, longo. Unpatterned: diamictite; fine obliquely hatched: clasts; dots: sandstone; lower continuous sinuous line: lower limit of outcrop (water surface(; niddle continuous or interrupted line: disconformity associated to boulder pavement; upper continuous line: upper limit of outcrop; coarse hatched area at right: bridge column.

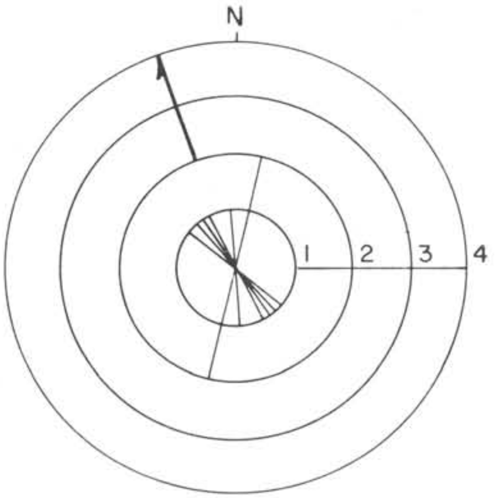

Fig. 4 - A

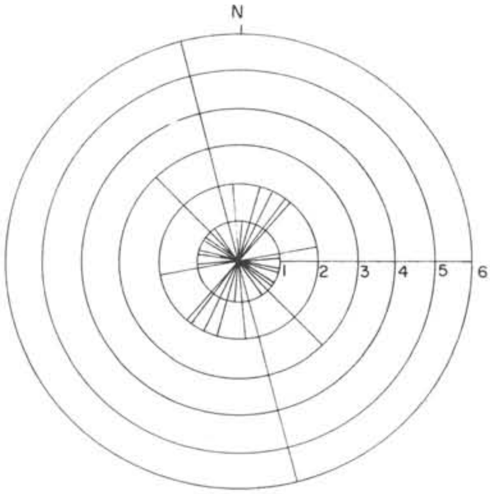

Fig. 4 - B

shown. The data indicate a reasonably good consistence and it seems that elongated diamictite clasts at Iongo were oriented parallel to ice-flow.

In summary, the glacial sediments at Iongo were probably transported by glaciers flowing from the southeast, an interpretation that is not contradicted by the lithology of clasts in the diamictites. In view of the local nature of the observation, however, it is premature to extrapolate this measurement for the whole Baixa do Cassanje area.

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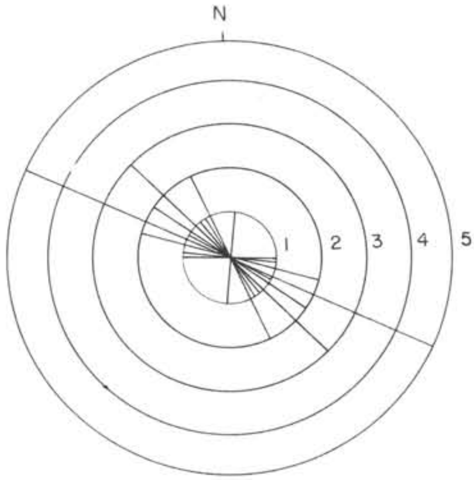

Fig. 4 - C

Fig. 4 Directional data. A: striae on clasts (7 determinations); arrow shows deduced sense of movement of glacier; B e C: elongation of clasts of two diamictites at Iongo-Milando road (B: 22 determinations; C: 20 determinations).

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