ABSTRACT: Most of the economic gold placers of the late Archean Witwatersrand Supergroup of South Africa have been found to be of fluvial origin. A downstream transition from the fluvial paleoenvironment to coastal environments is expected, but such facies changes have not been observed within the previously studied areas. In this paper, the sedimentology of the uppermost formations of the Supergroup in a distal part of the preserved basin, namely the Vredefort structure, is described and evidence for transition from fluvial through tidal to shallow marine depositional conditions is submitted. The study area comprises the exposed arcuate northeastern to southwestern sector of the Vredefort structure, where overturned strata dip radially towards its center. In the Vredefort structure, the upper subgroup of the Witwatersrand Supergroup, the Turffontein has been subdivided into five formations, for which the codes R1 through R5 are used. The succession between formations R4 through R5 is the subject of this study.

Only the upper part of the basal formation, R1, is exposed in the study area and comprises coarse-grained, trough and planar cross-bedded arenites, which are texturally moderately mature. Paleocurrent distributions are mostly unimodal, except in the extreme eastern region, where the distribution is polymodal. Formation R2 disconformably overlies formation R1 and consists of interbedded conglomerate and coarse-grained, cross-bedded arenites. Pebble size is largest in the northern parts of the study area and decreases towards the east. Paleocurrent distributions are unimodal in the western parts of the study area, but bimodal to polymodal in the central and eastern parts. Formation R3 conformably overlies formation R2 and comprises predominantly coarse-grained, moderately mature, trough and planar cross-bedded quartz wackes, with scattered small pebbles and thin conglomerates. Paleocurrent distributions of this formation, too, are unimodal in the western part of the study area and mostly bimodal in the remainder. A number of planar cross-bed sets with foreset packages separated by mudstone or immature sandstone laminae were found in the outcrops of the central and eastern parts of the study area. In some cases the thicknesses within series of consecutive foreset packages vary cyclically. A planar cross-bed set with mud-draped foreset packages was found towards the top of the formation in the eastern parts of the study area.

The mudstone-bounded foreset packages described are interpreted as tidal bundles and indicate a tidal setting for those palaeogeographic parts of the formations where they occur. Bimodal paleocurrent distributions provide additional evidence for tidal deposition. West of an imaginary point near the center of the study area, no indicators of tidal sedimentation have been found and all the formations were probably deposited by fluvial processes here. However, to the east of this point, which indicates the position of a paleo-bayline, formations R2 and R3 exhibit characteristics indicative of tidal deposition. Paleocurrents, and the decrease in pebble size of the conglomerates of formation R2 towards the east, suggest that its sediment was derived from a western source area, most likely in response to tectonic uplift and tilting here, and transported into a tidal environment by fluvial processes. The basal disconformity of this formation is thought to be a type 2 unconformity and the result of progradation of coarse-grained gravel across a paleo-surface comprising sand.

INTRODUCTION

The vast majority of the economic gold placers of the late Archean Witwatersrand Supergroup of South Africa occur within its upper group, the Central Rand. Sedimentological studies have shown that most of these placers are fluvial in origin and most probably were deposited in braided streams. Obviously, a downstream transition from these interpreted fluvial paleoenvironments to coastal environments can be expected, but such transitions have not been recorded within the mining areas, most of which are situated along the northeastern arcuate rim of the preserved basin (Fig. 1A). The well-known Vredefort structure is situated near the center of the preserved Witwatersrand Basin and the outcrops of this supergroup here represent distal facies, relative to those of the mining areas. The main objective of this paper is to document transitions from fluvial through tidal to shallow marine paleoenvironments for a coarse clastic sequence within the upper subgroup of the Witwatersrand Supergroup, the Turffontein, in the Vredefort structure. An additional objective is to offer hypotheses on the palaeoenvironmental nature of the proposed tidal environment.

GEOGRAPHIC SETTING, REGIONAL GEOLOGY, AND STRATIGRAPHY

The well-known Vredefort structure is situated towards the northern parts of South Africa in the vicinity of the towns of Parys and Vredefort (Fig. 1B). The structure, the exposed northern rim of which is often portrayed as semi-circular on large-scale maps, has a diameter of about 55 km and occurs roughly near the center of the preserved oblong Witwatersrand Basin, as depicted by Pretorius (1986). The Vredefort structure comprises a central granitic hub and an arcuate rim consisting of steeply dipping sedimentary and volcanic rocks of the Dominion Group, and the Witwatersrand, Ventersdorp, and Transvaal Supergroups. With the exception of the covered southeastern parts of the structure, the beds constituting the rim are mostly overturned, dipping perpendicularly towards the hub. The collar of the Vredefort structure can be considered to comprise a number of approximate straight-line segments, separated by inferred faults. Within each segment, tectonic strikes remain remarkably constant, but the mean tectonic dip azimuths show a gradual increase for successive clockwise segments. The Vredefort area abounds with intrusives of various ages and has been affected by thermal metamorphism, demonstrated by metamorphic facies variations within different regions of the structure (Bisschoff, 1982). Additional structural features include shatter cones (Albat, 1988) and planar shock fractu res (Albat and Mayer, 1989). After much controversy and debate, the initial hypothesis of Manton (1962) that the structure represents a meteoritic impact scar now seems to be accepted by the vast majori ty of earth scientists.

In spite of their complex post-depositional history, the arenaceous rocks of the Vredefort structure have generally remained remarkably undeformed and unaltered. In most cases, primary sedimentary structures are readily observed in these rocks and meaningful sedimentary petrographic investigations are possible. In some instances, however, sedimentary structures are obscured by the above-mentioned deformation features.

The Vredefort area was first mapped more than 60 years ago by Nel (1927), who subdivided the Central Rand Group into a