Chapter 4

Stratigraphy

4.1 Introduction

The stratigraphy of the succession at Nsuta (Fig 4.1) is described based essentially on descriptions of drill core. In the cores it was possible to distinguish younging directions of strata by making use of graded bedding in the greywackes. Other features that could be used to determine younging directions in the greywackes were sharp erosional basal contacts of individual greywacke beds with argillites, concentration of rip-up clasts in lower parts of greywacke beds and occasional load-cast and flame structures. These structures could also be used in outcrop at the mine to determine younging directions supplemented by the presence of sole marks at the base of greywacke units at a few localities.

The present study was inhibited by the fact that most drill cores were terminated once the basal contact of the carbonate ore bed with the underlying lower sedimentary unit was intersected. In order to accommodate for this lack of data, an average thickness for the lower sedimentary unit was taken from field observations. Only the upper part of the lower greenstone unit and the lower part of the upper greenstone unit are exposed in the mining area.

4.2 Lower Greenstone Unit (LG)

Outcrop of the LG (Fig 4.1) is very poor and it was only observed at a few localities in the field and in one or two drill-cores. Rocks exposed in the mining area in the upper part of the LG is best described as a volcaniclastic sedimentary unit that consists of a fine matrix (probably former volcanic ash) hosting larger volcanic clasts that can be classified according to the Udden-Wentworth grain-size scale *(Prothero and Schwab, 1996)* as ranging from coarse sand to medium-sized pebbles. Some clasts are cobble-size especially along the contact between the LG and the lower sedimentary unit (Fig. 4.2a). The majority of these clasts are angular to sub-rounded. The entire unit has a light green/grey-green colour and coarsens upward to immediately below the lower sedimentary unit (Fig 4.1).

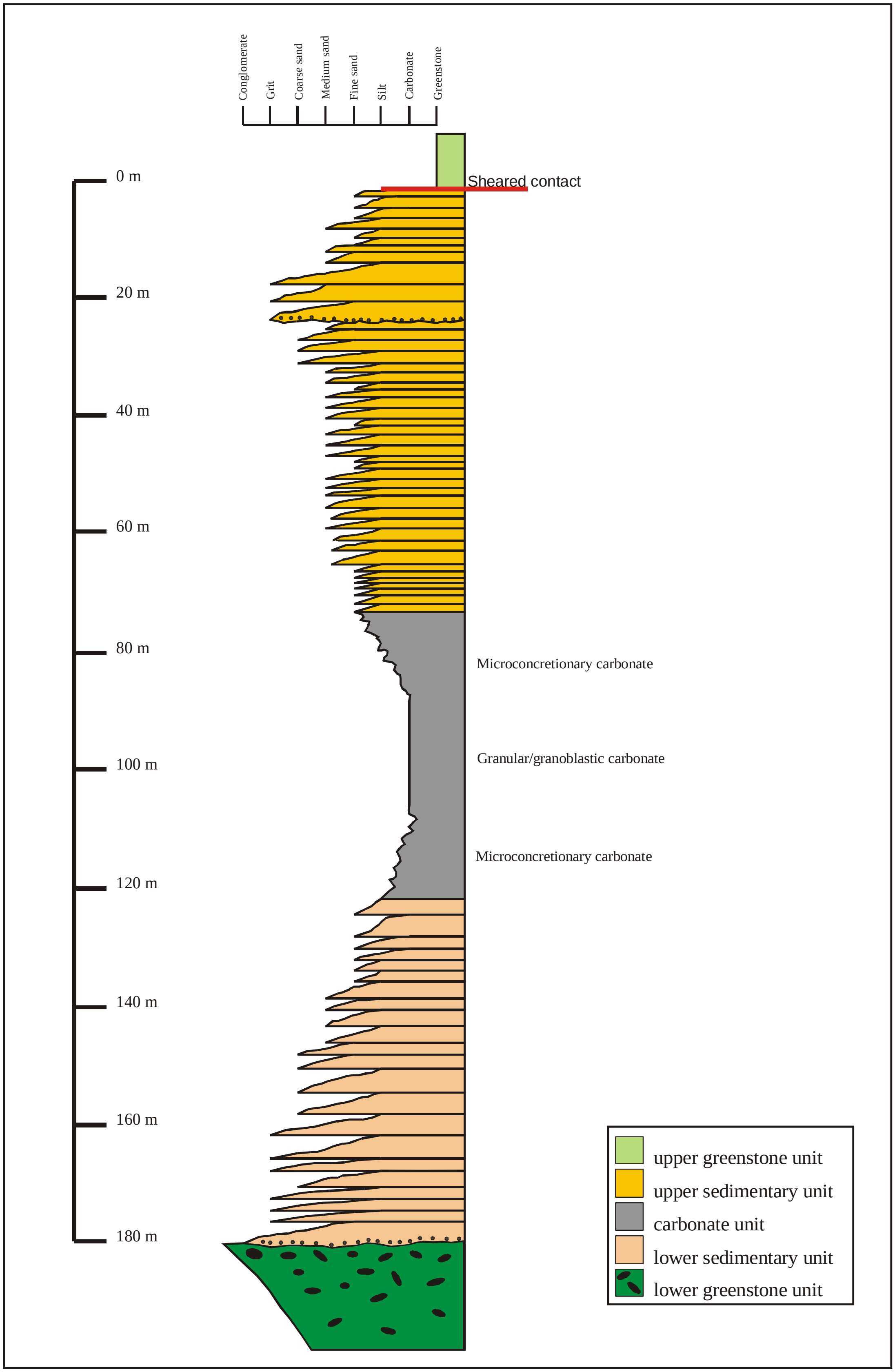

Figure 4.1. Generalised stratigraphic profile of the Nsuta manganese deposit.

4.3 Lower sedimentary unit (LS)

The contact between the lower sedimentary unit and the lower greenstone unit (Fig. 4.1) ranges from sharp conformable (Hill B, Fig. 4.2b) to unconformable (Hill D south and north) and is marked by a conglomeratic bed that contains clasts up to large cobble size (Fig. 4.2a). The clasts in this conglomerate are of mixed volcanic and sedimentary origin as indicated by the massive and laminated internal texture of clasts.

The lower sedimentary unit consists of interlayers of greywacke and argillite with minor phyllite. Argillitic beds become more abundant upwards in the succession defining an overall upward-fining sedimentary unit.

Greywacke beds are either single or amalgamated. Single beds are from a few centimeters to 120 cm thick and display graded bedding with a sharp erosional base. A few display typical Bouma cycles *(Bouma, 1962)* of graded bedding at the base, followed upwards by flat lamination, ripple cross-lamination and argillite. Amalgamated beds are up to several meters thick and typically contain graded and flat laminated Bouma units in coarse greywacke beds. Finer amalgamated greywacke beds contain flat lamination and poorly defined ripple lamination. Most cycles are marked by a sharp, sometimes erosional, basal contact that is very often accompanied by rip-up clasts and flame structures. Top contacts are often truncated by the following Bouma unit. The Bouma units reach a maximum thickness of about 120 cm. In a few cases sole marks are preserved at the base of units (Fig. 4.2c) and in others soft sediment deformation structures (contorted bedding) (Fig 4.2d) are preserved.

4.4 Carbonate unit (CU)

The carbonate unit usually appears as a very fine-grained massively textured carbonate rock; weak sedimentary lamination is only locally observed, especially in the transition zone to black argillites. The carbonate is light to dark grey in colour and fractures in a brittle manner.

Upper and lower contacts to the carbonate ore body can be described as gradational, with obvious transition zones between the siliciclastic and carbonate beds. Microconcretionary carbonates predominate in these transition zones. The central portion of the CU is, in contrast, composed of granular or, locally, of granoblastic carbonate ore. This part of the bed represents the carbonate orebody defined on the basis of Mn-grade on the mine. Approaching the manganese carbonate orebody, the sedimentary units gradually become more carbonate-rich until siliciclastic material is absent. The maximum stratigraphic thickness of the carbonate unit is about 80 m. The carbonate orebody itself in the central part of the carbonate unit, is on average 45 m thick.

4.5 Upper sedimentary unit (US)

This unit gradationally overlies the carbonate unit (Fig. 4.1) and consists of interlayered greywacke and argillitic beds that are on average about 30 cm in thickness (Fig. 4.3a). The lower part of this unit is argillaceous and becomes more sandy (more abundant greywacke) upwards in the succession. Greywacke beds also display graded bedding and flat lamination with rip-up clasts. In the upper parts of the unit a granulestone bed is developed. It contains granule-size clasts of siltstone and carbonate (borehole 3315, Hill C south). Above this bed the succession fines upward and becomes completely argillaceous based on observations at Hill B and Hill C south (Fig. 4.3b). The contact with the overlying upper greenstone unit is sheared and faulted (Fig. 4.1).

4.6 Upper greenstone unit (UG)

This unit (metalava?) overlies the sedimentary succession at the Nsuta deposit (Fig. 4.1). Its weathered equivalent is well represented in outcrop. Fresh upper greenstone is, however, extremely rare, and is usually only encountered in drill-core. Upper greenstone observed in the field can only be described as a highly weathered mafic volcanic rock. It is typically red/brown in colour and

strongly foliated especially near to the sheared contact with the underlying upper sedimentary unit. Although this unit is deeply weathered, it appears to consist of more fine- grained material and probably has a greater volcanic ash or lava content and less volcaniclastic material than the lower greenstone unit. Although fresh outcrop is rare, field observations suggest that the UG is more strongly chloritized and therefore appears to be khaki-green in colour as opposed to the LG that appears to be a lighter shade of green.

4.7 Lateral Variation

Fence diagrams were produced from dip-corrected borehole logs, one running north-south (Fig. 4.4) and the other NNE-SSW (Fig. 4.5). These diagrams illustrate that lateral correlation of the various lithological units is possible and that the UT, CU and LT are always consistent in their stratigraphic relationship.

Figure 4.5 illustrates a lateral change in carbonate unit thickness from 10 m to 50 m as well as the presence of additional thinner carbonate units that thin out laterally within the upper sedimentary unit. The carbonate unit (Fig. 4.4) appears to contain thin greywacke beds that pinch out laterally. Another observation (Fig. 4.5) is the presence of a thick amalgamated greywacke channel, approximately 25 m thick, in drill-core from Hill D north. It interfingers laterally with interlaminated greywacke and argillite beds.

Both fence diagrams indicate an upward-fining lower sedimentary unit, a massive carbonate unit followed by an upward-coarsening upper sedimentary unit. Construction of fence diagrams generates an impression of a laterally continuous trough-shaped depression that was partly filled by the orebody. In the vicinity of Hills C north and D north, the carbonate orebody and lower sedimentary unit seem to thin out dramatically (Fig. 4.4 & 4.5). However, this apparent thinning of the lower sedimentary unit is most probably due to structural deformation in the particular area.