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Vestiges of khondalite in some bauxite profiles, Visakhapatnam District, Andhra Pradesh

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Abstract

Vestiges of khondalite (garnet-sillimanite gneiss) occur sporadically in some bauxite profiles of Visakhapatnam district, Andhra Pradesh. Based on their mode of occurrence, the vestiges may be classified into (i) outcrop island, and (ii) sub-crop intercalation types. Neither of them has lateral nor downward persistence. Their occurrence within the residuum is by no means anomalous; instead, they are in conformity with the natural laws governing the processes of residual chemical weathering (RCW). Either the litho-textural and structural fabric of the vestige itself is resistant to RCW or the vestige may be circumscribed by a zone of impeded drainage that prevents thorough leaching locally. These vestiges are comparable to the kaolinised nepheline syenite pockets, within the bauxite residuum, of the well known Arkansas deposits in U.S.A., and the boulders of parent basic rock in the bauxite deposits of Sarawak.

Introduction

The geology, mode of occurrence and genesis of bauxite in the Eastern Ghats was described earlier (Ramam *et al.*, 1975; Ramam, 1976, 1978). Discussing the genesis of the Anantagiri bauxite deposits, Ramam (1976) observed 'Presence of unaltered bands of garnet-sillimanite gneiss within the bauxite residuum indicates certain zones of parent rock that apparently escaped lateritization/bauxitization'. Similar occurrences are recorded elsewhere also in the weathering profiles. An attempt is made in this paper to classify such vestiges and analyse the possible reasons for their selective 'resistate' nature. While the field work was shared by all the authors, the senior author takes full responsibility for the interpretations presented in this paper.

Vestiges of khondalite

The vestiges of khondalite occurring in some of the bauxite profiles may be broadly classified into two types, based on their mode of occurrence. They are (i) outcrop island, and (ii) sub-crop intercalation types.

Bauxite with pronounced relict foliations crops out extensively as blankets on the plateau tops. Small pockets of partially leached or unleached khondalite may occur sporadically amidst them. These are christened as the 'outcrop island' type as the unaltered/partially altered pockets of khondalite simulate islands in a sea of bauxite.

Thin partings/intercalations of partially leached khondalite occur associated with the bauxite residuum in some profiles at one or more levels. These are termed the 'sub-crop' intercalation types (Fig. 1) as they are a metre to 5 metres thick, with very restricted lateral persistence.

Discussion

Of the plethora of conjectures that could be visualised, the most plausible ones that would explain the occurrence of such vestiges are the following:

i) Originally the entire RCW profile, irrespective of its derivation by direct or a two-stage transformation, was of bauxite residuum and the vestiges of khondalite in it may be a sequel to resilication.

ii) RCW of the khondalite initially resulted in kaolinisation and on further desilication, the bauxite residuum was formed. During the process of desilication that has probably not ceased yet (?), small bodies of partially leached (kaolinised) khondalite are left behind as vestiges within the residuum.

iii) RCW of khondalite resulted in direct transformation to bauxite residuum and the small, lenticular bodies of the partially leached khondalite may be attributed to local unfavourable conditions such as (a) the intrinsic lithological, textural and structural fabric of the vestiges themselves not being conducive for thorough leaching and consequently forming 'resistates' and (b) the intrinsic fabric of the vestige may be conducive for effective RCW but the circumjacent impermeable zone prevented, locally, the percolation of circulating waters and consequential leaching.

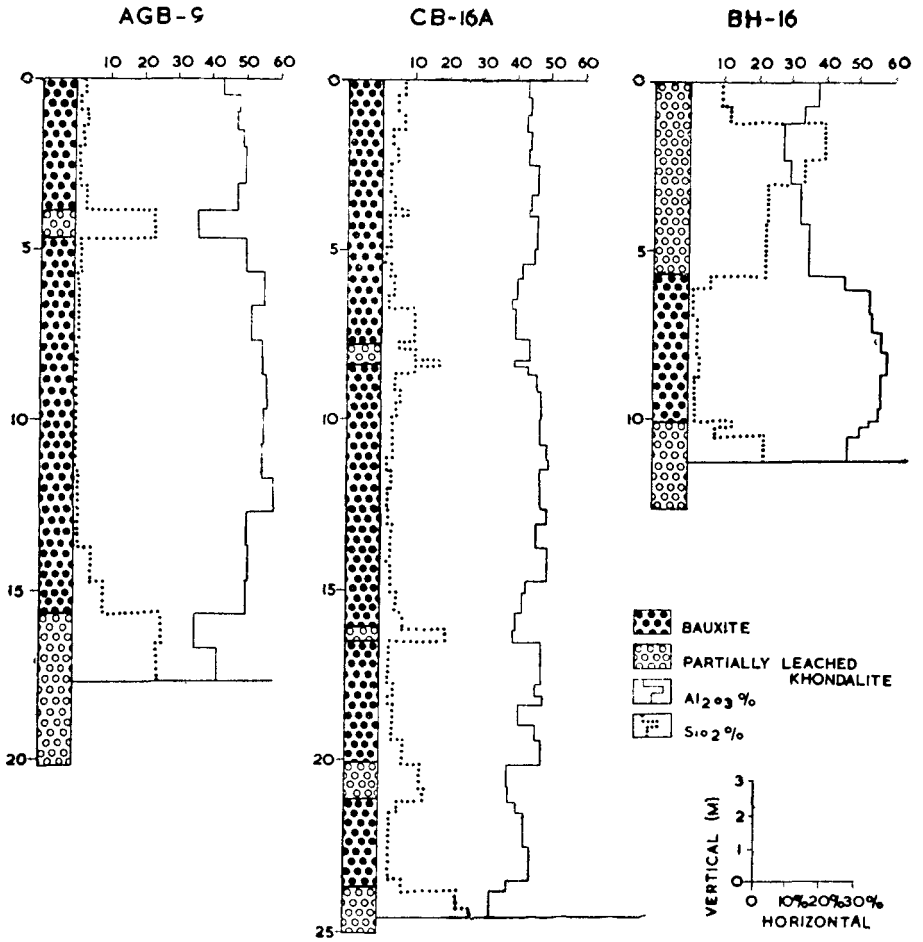

Figure 1.

Alternative (i) necessarily implies introduction of silica subsequent to bauxitisation. Therefore, there has to be a source of silica. Unlike many other bauxite deposits where the transition between the residuum and subjacent rock is marked by an intercalation lithomarge, the bauxite profiles in Visakhapatnam and adjacent areas have, in general, either a partially leached khondalite or an admixture of partially leached khondalite and clay, marking the transition. Further, the water table is far

below the transition in these profiles. This, therefore, rules out the possibility of resilication by the upward migration of kaolin due to capillarity, consequent upon the seasonal fluctuations in groundwater level.

Isovolumetric transformation as evidenced by the well preserved relict foliations in bauxite conforming to the trends of subjacent and adjacent khondalites and pseudomorphs of gibbsite after feldspar, sillimanite and garnet proves that the bauxite residuum was a sequel to direct transformation from the khondalite with no intervening kaolin phase. Alternative (ii) is therefore ruled out.

The sub-crop profiles in Fig. 1 shows (a) the vestige itself being a resistate (AGB–9), (b) a resistant zone surrounding the vestige preventing its thorough leaching (CB–16 A) and (c) the outcrop island type made up of a massive garnetiferous-quartzite with no pronounced jointing or fracturing. Feldspar and sillimanite are scarce. Both garnet and quartz are resistates in the order of stability. The lithological-textural-structural fabric is evidently not conducive for effective RCW and it remained as a vestige. The very fact that good grade bauxite was intersected below the vestige amply demonstrates the diminishing lateral and vertical dimensions.

Such vestiges are reported from several deposits whose *in situ* origin was established beyond doubt and they are seemingly a common phenomenon. The nepheline syenite boulders in the bauxite residuum of Arkansas, U.S.A. (Gordon & Tracy, 1952) and the boulders of parent basic rock in the bauxite deposits of Sarawak (Harder, 1952) are some other parallel instances.

Conclusion

Differential removal of certain constituents leaving behind a residue that has undergone neo-mineralisation is the essence of RCW. Naturally it is a complicated phenomenon involving many processes and variables (Reiche, 1943). The decisive role of lithology, texture and structure has already been identified in respect of the bauxite profiles in Visakhapatnam district (Ramam, 1978). This is in conformity with the credence given to the parent mineral structure in controlling the accessibility of the percolating waters to the bonding cations in silicate weathering (Loughnan, 1962). Alternative (iii) thus appears to be a plausible explanation for the occurrence of vestiges of khondalite within the bauxite residuum.

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