Oceanic-plateau ultramafic lavas and arc-related intrusives in two contrasting ultramafic complexes from the Paleoproterozoic Guiana Shield

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Introduction

The early Proterozoic (Rhyacian) greenstone belts of South America and West Africa show widespread evidence for subduction and contain rare ultramafic magmatic rocks. The significance of these young greenstone belts in global models for crustal growth remains unclear. Here we studied two contrasting ultramafic complexes from the Guiana Shield in Suriname, that formed during the Trans-Amazonian Orogeny (ca. 2.18–1.95 Ga)[1-3]:

- The Bemau Ultramafic Complex (BUC; Fig. 1, 2A) is part of the Marowijne Greenstone Belt (MGB) and is associated with partially pillowed metabasalts of the Paramaka Formation.
- The Borgia Hill Chromite Complex (BHCC; Fig. 1, 2B) outcrops in an isolated greenstone enclave in a large granitoid terrain further south[4].
- Both BUC and BHCC show plutonic cumulates and altered ultramafic schists (Fig. 3, 4).
- They show variable associations (Fig. 3, 4), alteration textures (Fig. 5) & geochemistry (Fig. 6, 7).

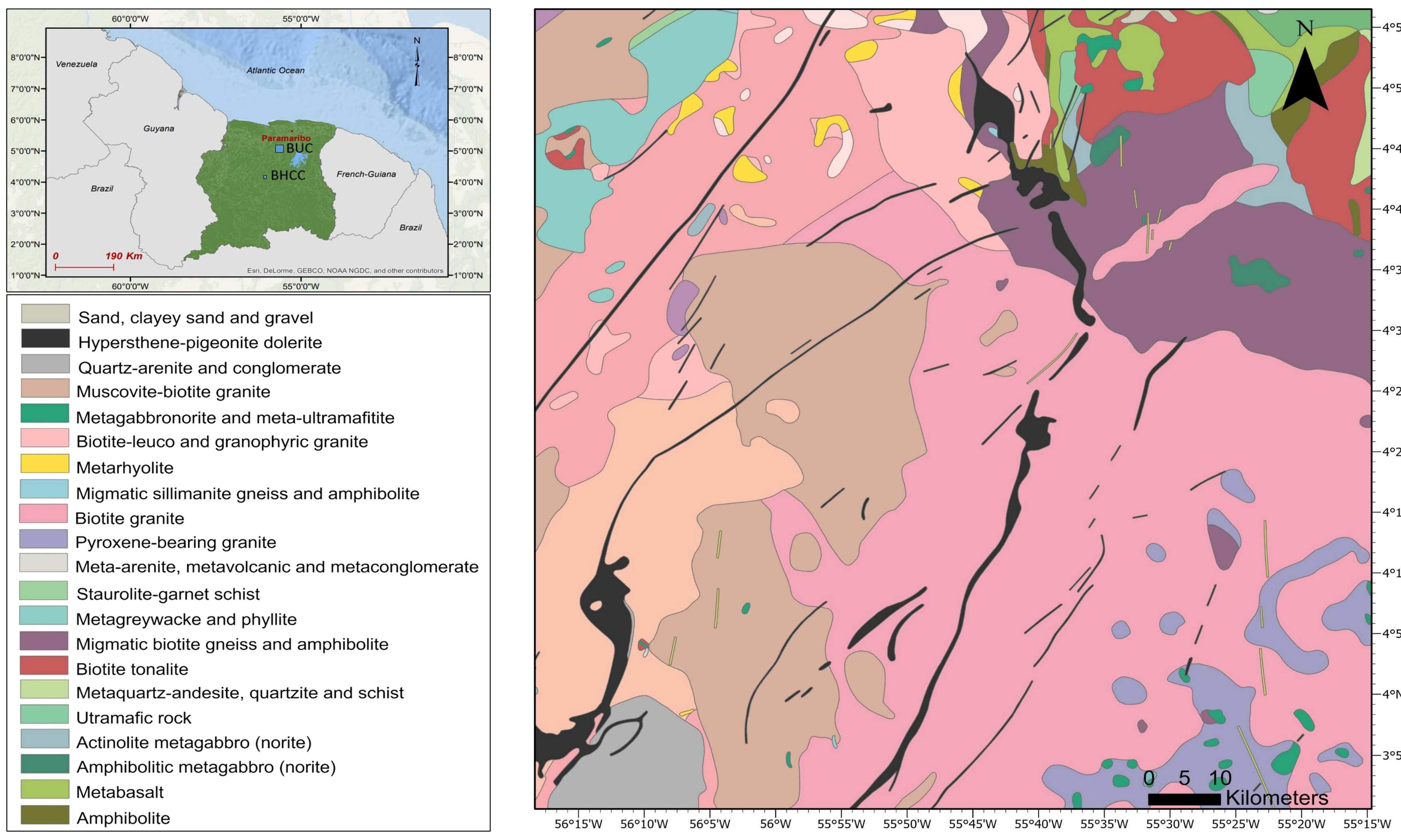


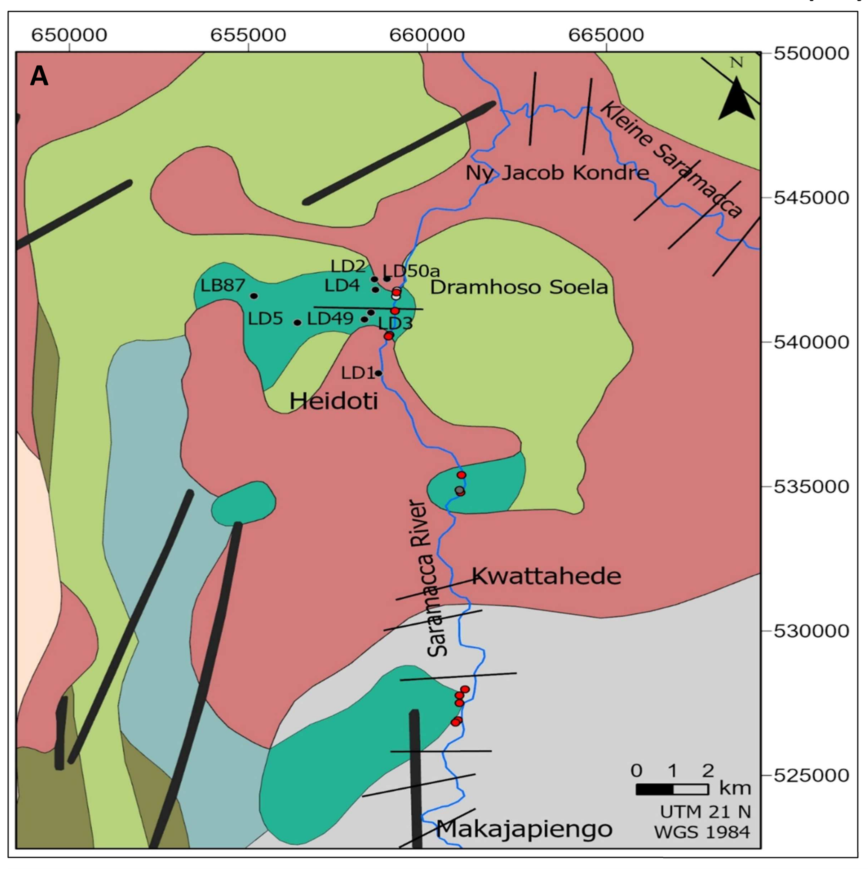
Figure 1: Excerpt from the Geological map of Suriname (Geological and Mining Department of Suriname, 2018).

Problem statement

The nature of the emplacement of the BUC and BHCC ultramafic rocks are still not understood. Are the BUC ultramafic lavas from the same magmatic pulse as the cumulates? Or did the cumulates intrude into older ultramafic lavas? What, if any, is the relation between BUC and BHCC?

Geological setting

- The oldest rock types in the MGB are ultramafic schists from the BUC, tholeiitic ocean-floor metabasalts[5] of the Paramaka Formation (<2.16-2.14 Ga[1]; Fig. 1) followed by mafic-ultramafic rocks, including the BUC cumulates.
- The BUC consists of ultramafic schists, partly serpentinized cumulate dunites, wehrlites, clinopyroxenites, websterite and gabbros intercalated with cumulate textured ultramafic schists (Fig. 3-5)[6,7], intruded by TTG plutons around 2.18-2.13 Ga.
- The BHCC lies in the centre of Suriname (Fig. 2B) and contains chromite bodies[4] associated with talc-tremolite schists, tremolite and anthophyllite rocks, all of peridotitic origin (Fig. 3-5).



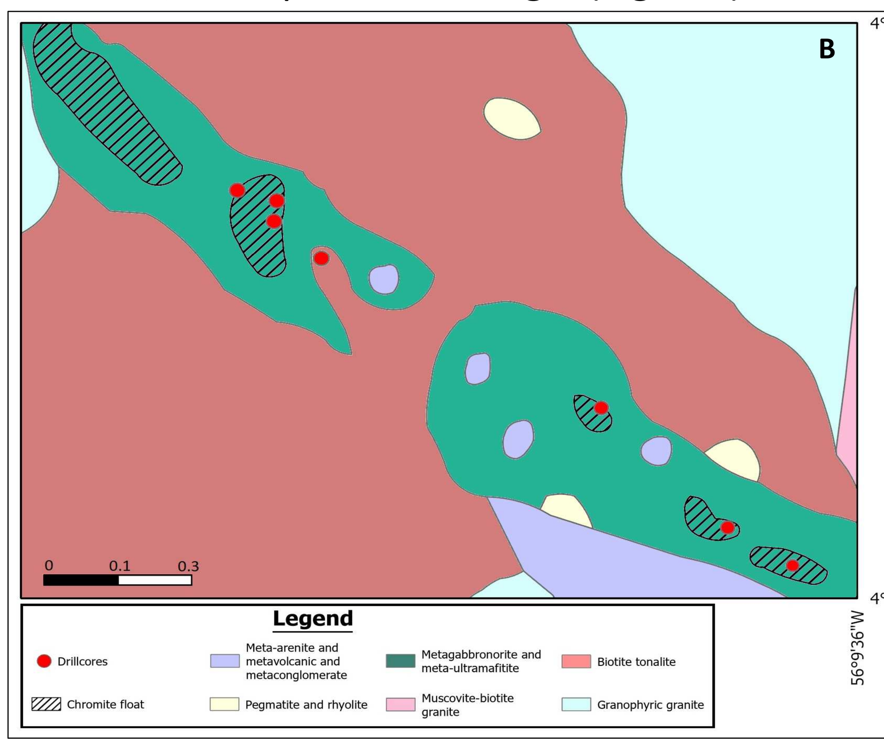


Figure 2: Part of the geological map of Suriname: (A) showing the BUC and surrounding rocks; (B) the BHCC and surrounding rocks.

Drill core logging

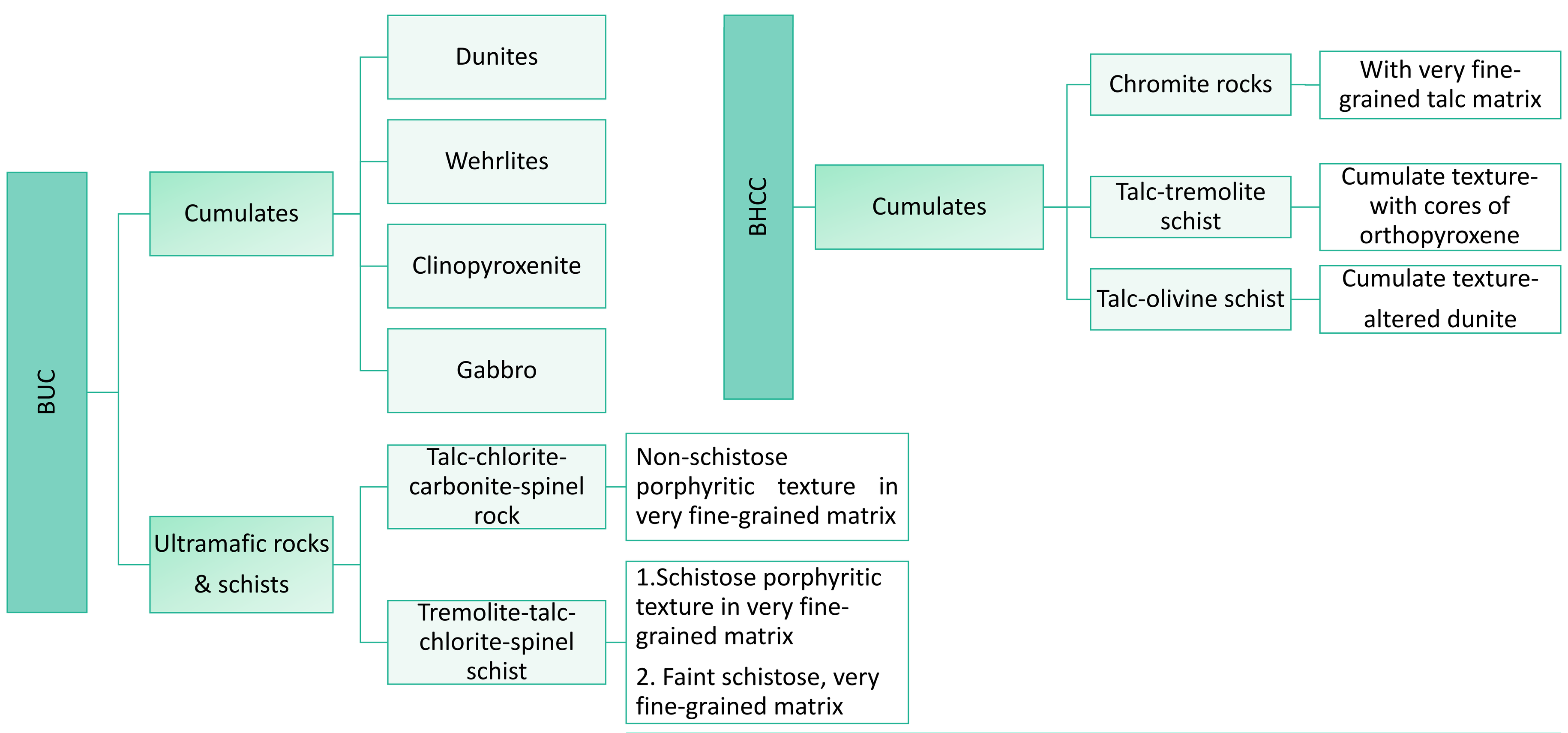


Figure 3: Schematic overview of drill core logging of the BUC and BHCC rocks.

Petrology

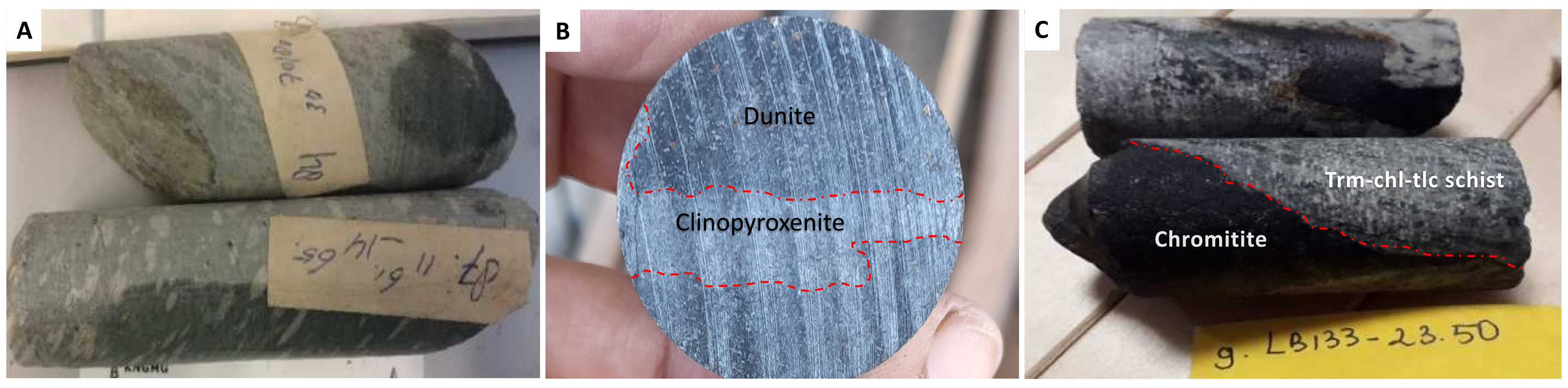


Figure 4: (A) Talc tremolite chlorite schist with carbonate talc domains; (B) contact dunite and clinopyroxenite-BUC; (C) chromitite-tremolite chlorite talc schist-BHCC.

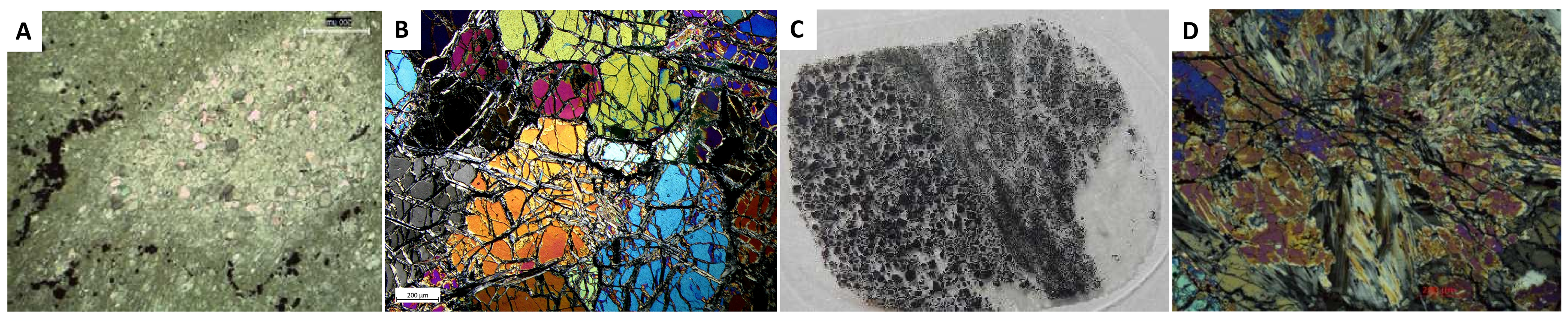


Figure 5: (A) Talc-tremolite-chlorite schist with deformed carbonate-talc domains surrounded by magnetite grains-BUC; (B) olivine crystals with serpentine and magnetite network in dunite-BUC; (C) chromite cumulate texture in rocks-BHCC; (D) alteration of olivine after talc and tremolite in ultramafic schist-BHCC.

Geochemistry (XRF and LA-ICP-MS)

- The metavolcanic ultramafic schists from BUC show significantly lower SiO_2 (46 wt%) and higher MgO (31 wt%) values than the metaplutonic schists from the BHCC (54 wt% SiO_2; 28 wt% MgO) (Fig. 6A).
- BUC ultramafic schists show flat primitive chondrite-normalized REE patterns; those of the BHCC and the cumulates from BUC have more enriched and variable values (Fig. 6B).
- BUC ultramafic schists were derived from a primitive mantle source (Fig. 6C) and plot as oceanic plateau basalts (Fig. 6D). They are probably of komatiitic origin (Fig. 7).
- Cumulates from both the BUC and BHCC show an arc-related affinity (Fig. 6C, D).

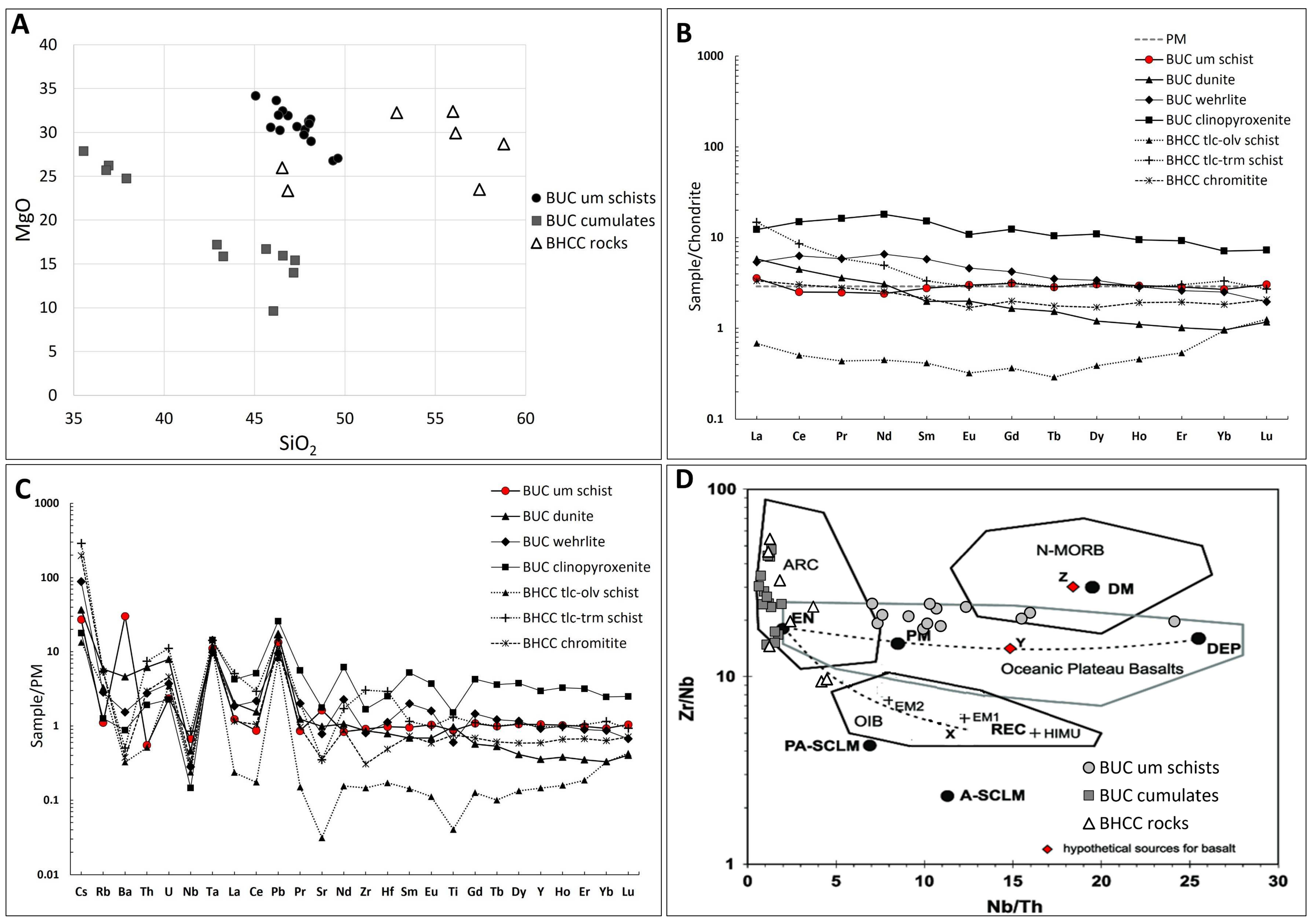


Figure 6: (A) Variation diagram of MgO versus SiO_2 (wt %) of the BUC ultramafic schists, BUC cumulates[7] and BHCC rocks; (B) chondrite[8] normalised REE plots; (C) primitive mantle[8] normalised trace element plots; (D) geochemical affinity-based diagram using Nb/Th vs Zr/Nb ratios[9].

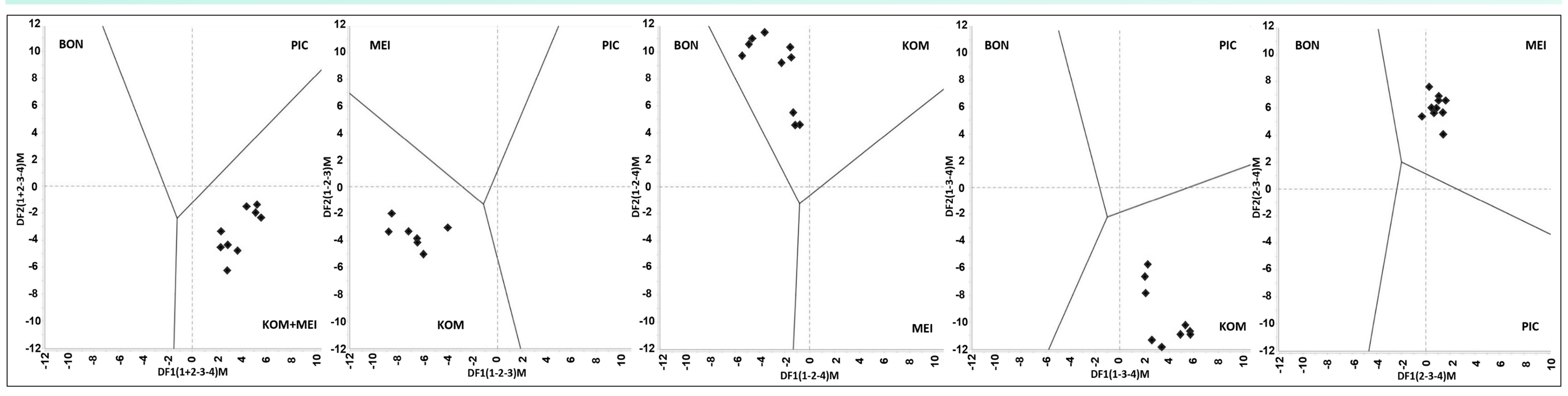


Figure 7: Log-ratio transformed major element based multidimensional classification for altered high-Mg igneous rock[10].

Conclusions

Although no spinifex textures are found in the BUC ultramafic schists, these rocks are geochemically classified as komatiitic rocks with oceanic plateau basalt affinity. The protolith of these rocks were derived from a primitive mantle source and were probably brought to surface during the first phase of the Trans Amazonian Orogeny. The cumulates are arc related rocks, which most-likely intruded during the second phase. The BHCC also show arc affinities, however with different rock associations compared to the BUC cumulates.

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