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From intra-oceanic subduction to arc accretion and oblique arc-continent collision: Insights from the P-T-D-t path of the southern Río San Juan metamorphic complex, northern Dominican Republic

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An integrated structural, petrological, geochemical and geochronological study was undertaken to constrain the origin, structural development and tectonic control on the exhumation of the high-P Cuaba Unit. Located in the southern part of the Río San Juan Metamorphic Complex, northern Dominican Republic, the Cuaba Unit defines a ∼40 km long and 2.5-6 km wide, NW-SE-elongated metamorphic complex. Structurally, it is divided into two zones: an internal antiformal core and an outer shear zone. The core, or lower Guaconejo subunit, consists of retrograded eclogites, garnet-bearing mafic and ultramafic gneisses, metagabbros, metadiorites, subordinated migmatites and mylonitic rocks. The outer shear zone, or upper Jobito subunit, is composed of amphibolites with a strong S-L fabric and metadiorites. The Jobito and Guaconejo subunits are juxtaposed by several rootless bodies of SSZ serpentinized peridotites, sheared Hbl-bearing tonalites and variably retrogressed high-P amphibolites. The unit is also juxtaposed against the underlying Helechal peridotite. Whole-rock geochemical analyses indicate that mafic rocks of the Cuaba Unit originated from low-Ti and low-LREE IAT, IAT, N-MORB and calc-alkaline type protoliths.

The evolution of structural fabrics and P-T metamorphic conditions recorded in the Cuaba Unit allows identifying (1) a prograde metamorphism (D1-M1) from amphibolite and high-P epidote-garnet amphibolite to eclogite facies conditions, and (2) a retrogressive event (D2-M2) to mid/low-P amphibolite and greenschist facies conditions. The M2 stage consists in an isothermal decompression and was accompanied by variably partial melting of mafic litologies. U-Pb TIMS dating on zircon grains (89.73±0.15 Ma) coupled with 40Ar-39Ar analyses on pargasite/aluminous tschermakite (∼89 Ma to 83 Ma), placed temporal constraints on the exhumation path from the M1 pressure-peak (Turonian-Coniacian boundary) to the M2 stage (Coniacian and Santonian). Zircons in early D2 garnet+zoisite-bearing felsic melts exhibit a positive Ce anomaly relative to chondrite, an overall flat HREE pattern, and no significant negative Eu anomaly, which provide evidence for zircon growth under eclogite facies conditions. Structural and sedimentary data confirm the existence of a regional, Late Oligocene to Miocene contractional event in the complex (D3), as well as two additional late brittle deformations (D4 and D5).

The compilation of this pressure-temperature-deformation-time path supports that an early subduction-related D1 deformation and high-P M1 metamorphism, was followed by a D2 extensional shearing deformation and M2 retrograde decompression, at exhumation rates of 3-4 km/Ma. The dominant tectonic mechanism responsible for exhumation of high-P rocks in the Cuaba Unit was therefore the D2 extensional tectonics, which caused tectonic juxtaposition and local metamorphic pressure gaps within the structural pile. This P-T-D-t evolution indicates that the Cuaba Unit experienced initial subduction, subsequent underplating below the forearc wedge of an island-arc, and final exhumation in the accretionary prism. At the regional scale, the Cuaba unit could be a fragment of the proto-Pacific arc that collided and was accreted bellow the E-facing, intra-oceanic, Caribbean island-arc, prior to final oblique collision with the paleo-continental margin of North America.