



## **Tonian oceanic crust processes decoded with multi-techniques from metamorphosed, hydrothermal, coetaneous zircon-tourmaline, southern Brasiliano Orogen**

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Metamorphosed, hydrothermal, coetaneous zircon-tourmaline assemblages document the dynamic evolution of Tonian oceanic crust, southern Brasiliano Orogen. Multi-technique, grain internal structure and composition (BSE imaging, EPMA analyses, characteristic X-ray maps, LA-ICP-MS trace element and U-Pb-Hf-B isotopes) relates the minerals to evolution of Rodinia and Gondwana Supercontinents. Tourmaline is a resilient, much-informative accessory mineral, and thus a proxy for identification of diversified geotectonic environments. We describe massive tourmalinites from Ibaré and Bossoroca ophiolites which obducted onto an oceanic island arc along low amphibolite facies thrusts. The long-lived process (950-660 Ma) also formed the Cambaí Complex of juvenile granitic rocks. This work aims to characterize tourmaline and zircon inclusions. In the field, massive tourmalinites with 1 to 30 m in size (and chloritites) are enclosed in metaserpentinite (olivine + talc + chromite, jackstraw texture, low amphibolite facies) and close (1-50 m) to amphibolite and listvenite. Tourmaline crystals are fibrous up to 20 cm in length. Under the optical microscope, tourmaline only displays zoning in a narrow light rim. Intense cataclasis fractured and broke the crystals, generating vugs. Chlorite is present in two generations. Chl 1 is in apparent equilibrium with homogeneous, core tourmaline, whereas Chl 2 is in equilibrium with tourmaline rim. Zircon occurs in tourmaline mostly in strings of small (5-10  $\mu\text{m}$ ) crystals but reaching 50  $\mu\text{m}$ . EPMA analyses display dravite. Composition is dominated by Si, Al, Fe, Mg, with low contents of Na and Ca. Fe<sup>+3</sup>, Ti, Cr, Mn, K, F, Cl and Li contents are negligible. Ibaré tourmaline is homogeneous, but three zones of different gray tones are observed in Bossoroca tourmaline in backscattered electron images (BSE) – Tur 1, Tur 2, Tur 3. These zones were also displayed in EPMA compositions, because elemental variations in Tur 1, Tur 2 and Tur 3 zones observed in BSE images and compositional X-ray maps find correspondence in  $\delta^{11}\text{B}$  distribution. Based on isotopic determinations, Ibaré tourmaline has  $\delta^{11}\text{B} = +5$ , whereas Bossoroca tourmaline Tur 1 has  $\delta^{11}\text{B} = +1$  to  $+2.2$  (peak at  $+1.8$ ), Tur 2 has  $\delta^{11}\text{B} = -1$  to  $+0.4$  (peak at 0), Tur 3 has  $\delta^{11}\text{B} = -8.2$  to  $-9.2$ , peak at  $-8.5$ ). U-Pb zircon ages from tourmalinite indicate hydrothermal crystallization near 900 Ma and partial recrystallization near 700 Ma. We interpret the results as indicating that the tourmalinites formed in oceanic crust ( $\epsilon_{\text{Hf}} = +12$ ) environment at 900 Ma, mid-ocean ridge environment (initial fragmentation of Rodinia), later accreted to Gondwana near 700 Ma. Most significant is the oceanic crystallization of Ibaré tur and Tur 1 and Tur 2 from Bossoroca, contrasting with partial recrystallization (Tur 3) in shear zone in the continent. Comparative resilience of zrn-tur indicates that cores of both minerals formed at 900 Ma from oceanic water, dated rims of zircon and tur 3 at 700 Ma, but zrn shows no evidence of recrystallization during tur 3. Intra-grain characteristics of zrn-tur from massive tourmalinite help elucidate processes at the grain to plate-scale.