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Dynamics of the thermal aureole of the Sudbury impact melt sheet, Canada

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The 1.85 Ga Sudbury Igneous Complex (SIC), a crystallized impact melt sheet, and its thermal aureole are the only accessible rock units on Earth permitting to study the metamorphic and deformational processes between a large impact melt sheet and adjacent target rocks. Until today, information regarding the influence of temperature on the mechanical behavior of granitoid and gneissic target rocks in the thermal aureole is sparse. The Footwall Breccia, an approximately 50 m wide heterolithic breccia, comprised of target rock fragments within a magmatic, dioritic to granitic, matrix lining the contact with the SIC, is the most prominent lithology of the thermal aureole. Although the Breccia has been studied for more than 30 years, there is no consensus regarding its origin. Based on a microstructural analysis of Footwall Breccia and adjacent host rocks, detailed geological mapping and G.I.S-based thickness calculation of Footwall Breccia and overlying basal Sublayer of the impact melt sheet, we shed light on this controversial topic. The level of recrystallization of target rocks allowed us to divide the thermal aureole into three zones: (1) an 800m wide outer zone, displaying the onset of static recrystallization at temperatures of about 450°C, (2) an approximately 650 m wide central zone, heated to temperatures of about 520°C, and (3) an 140 m wide inner zone, subjected to temperatures exceeding 650°C. Approximately 80 % of the Footwall Breccia rocks display a poikilitic texture, interpreted to have formed from partial melting of target rocks. These observations point to a profound influence of heat imparted by the SIC on adjacent target rocks and account for; (1) large complementary thickness variations of Footwall Breccia and Sublayer, (2) protrusions of one into the other, and (3) gradational contacts between the two units. Collectively, these characteristics indicate a high mobility of these units under high temperature following cratering.