THE GRAVITY SETTLING MYTH: NEW THEORIES ON CHROMITITE FORMATION IN THE BUSHVELD COMPLEX

Geol 5903: Graduate Seminar - Dylan McKeen

Abstract

The Bushveld Complex (BC) in South Africa has long been the subject of extensive study by geologists. This huge Precambrian intrusion is remarkably well-layered and contains large economic mineral endowments of platinum group elements (PGE), chromium, and iron. Despite thorough investigations, consensus on formation of the BC remains elusive. Understanding the origin of massive chromitite layers is a key issue in elucidating how the BC formed. The critical question is: did chromitite layers form from chromite crystals settling out of suspension in a melt due to gravity or did they form by crystallizing in situ on a magma chamber floor? Both classic and recent models have postulated that gravity-driven processes such as kinetic sieving and gravity settling are critical in forming massive chromitite layers. Some of the best lines of evidence supporting gravity settling are from mass balance calculations and thermodynamic models which indicate cotectic crystallization of orthopyroxene and chromite in a staging chamber before emplacement, necessitating crystal settling after emplacement. However, new models suggest that in situ crystallization is a more realistic process. Evidence for in situ growth includes field relationships that show chromite crystallizing top down from the bottom of overhanging wall rock, and X-ray tomography showing an interconnected network of chromite crystals nucleating on one another. The best-fit model will not solely inform on emplacement processes in the BC; it will also provide exploration criteria for PGE and chromium deposits in other similar intrusions.