Research shows that the Bushveld Complex functioned as a big magma tank

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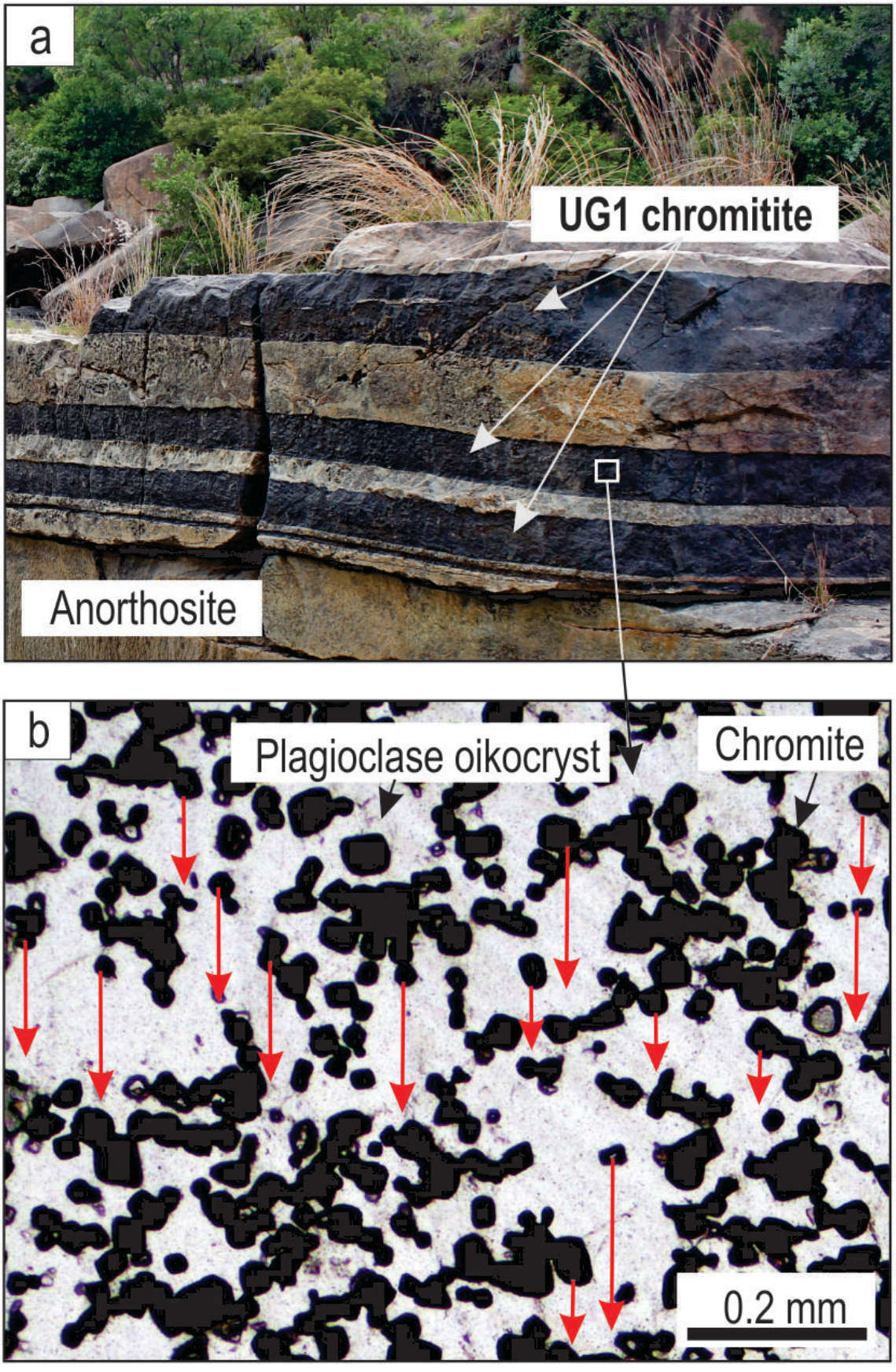

a
UG1 chromitite
Anorthosite
b
Plagioclase oikocryst
Chromite
0.2 mm

Panoramic view of the UG1 chromitite in the anorthosite footwall at the Dwars River, Eastern Bushveld (a) with red arrows (b) emphasizing that chromite grains show no tendency to settle downwards despite a high porosity of the framework. Credit: Wits University

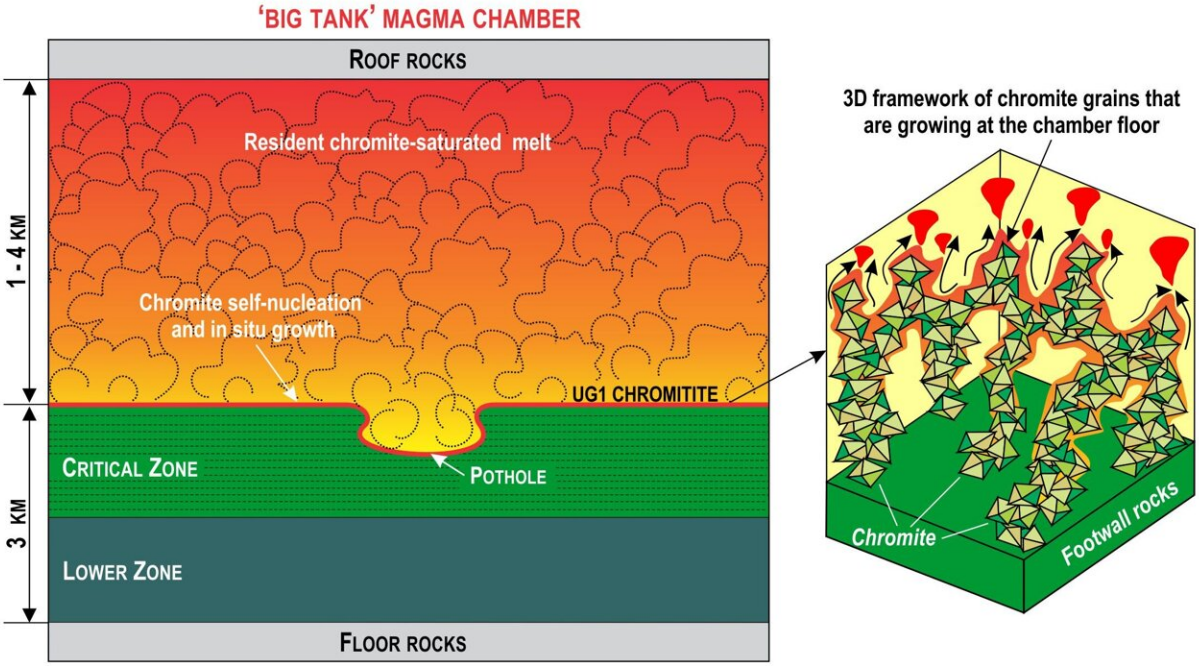
An international group of researchers led by geologists from Wits University in Johannesburg have come up with multiple lines of evidence indicating that the Bushveld Complex in South Africa functioned as a "big magma tank" in the ancient Earth's crust. This research was published as a paper in *Scientific Reports*.

Professor Rais Latypov from the School of Geosciences at Wits University says "While re-examining thin-sections of Bushveld chromitites, we noticed a very puzzling observation: chromite often occurs as individual grains that seemingly 'suspended' within matrix minerals. This observation leads us to a critical question: why have the chromite grains failed to sink towards the chamber floor despite being much denser than the host melt?"

To answer this question, the researchers have studied chromitite in three-dimensions (3D) using high-resolution X-ray computed tomography and revealed that nearly all chromite grains are closely interconnected to form a single continuous 3D framework. "This gave us an answer to the above question: chromite grains are not able to settle freely towards the chamber floor simply because they are all bound together in self-supporting 3D frameworks attached to the chamber floor," says Dr. Sofya Chistyakova from the School of Geosciences at Wits University.

There is only one process that may result in the formation of such 3D

frameworks of chromite crystals. This is an in situ self-nucleation and growth of chromite grains, for example, when all new chromite grains nucleate and grow on pre-existing chromite grains directly at the chamber floor. This happens from the parental melt that is saturated in chromite as the only crystallizing phase.



A 'big-tank' chamber of the Bushveld Complex (a) filled with a resident melt that crystallizes into the UG1 chromitite at the chamber floor as a 3D framework of touching chromite crystals (b). Credit: Wits University

"This logically brought us to a long-known Cr mass balance issue—normal basaltic melts contain only a very small amount of Cr so that the formation of thick chromitite layer requires extraction of Cr from a very large volume of liquid that must be present as a thick melt layer in the chamber. Simple mass balance calculations indicate that a 1

meter thick layer of chromitite will require a magma column of 2km to 4km thick," says Latypov.

Latypov and his co-authors believe that the enormous lateral extent of chromitite layers indicate that during the formation of massive chromitites the Bushveld chamber was operating as a giant magma body of more than 400km in diameter, with a column of the resident melt likely attaining a few km in thickness. "This conclusion is at odds with a currently emerging school of thought is that such large, long-lived and largely molten magma chambers are non-existent in Earth's history," says Latypov.

More information: Rais Latypov et al, Chromitite layers indicate the existence of large, long-lived, and entirely molten magma chambers, *Scientific Reports* (2022). DOI: 10.1038/s41598-022-08110-6

Provided by Wits University