

Geology 222b Laboratory Project

Layered Mafic Intrusions

Layered mafic intrusions present an unusual record of a natural crystallization experiment. In an ideal case, a magma chamber is filled with a mafic liquid of relatively low viscosity. Crystals of sufficient density that grow from this liquid settle to the bottom of the magma chamber as they grow. Layers of crystals are formed yielding a “magmatic sedimentary rock”. The first-formed crystals are on the bottom of the magma chamber and later-formed crystals are stratigraphically above earlier-formed crystals. If one looks at the compositions of the crystals in the layers, changes that occur during the solidification of the magma can be discovered.

Actual layered mafic intrusions are rarely as simple as the idealized model. Crystal settling can be rhythmic rather than continuous. Density currents can develop and lead to cross-bedding. Some (intercumulus) liquid can be trapped as a pore fluid among the settled crystals and possibly be squeezed out as the crystal layers are compressed. Additional batches of magma can be added to the magma chamber over time.

We have available suites of samples from three layered mafic intrusions (Stillwater, Kiglapait, and Bushveld). The class will be divided into groups of 3-4 persons. Each group will select one of the three rock suites. Each member of the group must describe carefully two rocks from the layered intrusion (full petrographic description, including hand sample, photomicrograph, mode, and name). In addition, the group must collect chemical data on the minerals in their suite using the SEM/EDS (with help from the instructors!). The group work is to be summarized in a report describing the crystallization history of the suite using the group's data, **both petrographic and chemical**, as well as **information obtained from the literature** on these intrusions.

Rocks from the Stillwater Complex

1. Cordierite-hypersthene-quartz hornfels. Just below the basal contact. Ridge above the Benbow Mine. (Hess, p. 52-55)
2. Chilled gabbro. Basal Zone. Ridge above the Benbow Mine. (Jackson, p. 2; Hess, p. 52-55).
3. Bronzite. Basal zone. Representative of about 700 feet at the base of the complex in this locality. Ridge above the Benbow Mine. (Jackson, p. 2, 14)
4. Poikilitic harzburgite. Ultramafic zone. Mouat Mine dump, from the interval between G and H chromitite layers. (Jackson, p. 5-8)
5. Granular harzburgite. Ultramafic zone. Mouat Mine dump as No. 4. (Jackson, p. 508)
6. Feldspathic poikilitic harzburgite. Ultramafic zone. Most specimens show some euhedral olivine crystals. Mouat Mine dump as no. 4. (Jackson, p. 5-8)
7. Serpentinized poikilitic harzburgite. Ultramafic zone. Benbow Mine dump. (Jackson, p. 5-8; Hess, p. 58)
8. Gabbro pegmatite. Ultramafic zone. Feldspar, 2 pyroxenes. Mouat Mine dump as No. 4. (Jackson, p. 8)
9. Chromitite. Ultramafic zone. G chromitite layer. Mouat Mine. (Jackson, p. 8)
10. Olivine chromitite. Ultramafic zone. H chromitite layer. Mouat Mine (Jackson, p. 8)
11. Bronzite. About 1000 feet above base of the Bronzite member of the Ultramafic zone. Benbow Road. (Jackson, p. 5)
12. Norite. About 1000 feet above base of Norite zone. Benbow Road. (Hess, 70-75)
13. Feldspar-rich gabbro. Lower gabbro zone. Benbow Road (Hess, p. 75-81)
14. Pyroxene-rich gabbro. Lower gabbro zone. Contains sulfides. Mouat Road. (Hess, p. 70-81)
15. Troctolite. Base of anorthosite zone. (Olivine altered). Benbow Road. (Hess, p. 81-83)
16. Anorthosite. Anorthosite zone. Picket Pin Road at head of Castle Creek.
17. Olivine gabbro. Anorthosite zone. Picket Pin Mountain. (Hess, p. 81-83)

Hess, H.H. (1960) *Stillwater Igneous Complex, Montana*, G.S.A. Memoir 80.

Jackson, Everett D. (1961) Primary Textures and Mineral Associations in the *Ultramafic Zone of the Stillwater Complex, Montana*, U.S.G.S. Prof. Paper 358.

Samples from the Bushveld Complex				
<u>Sample</u>	<u>Approximate height in layered sequence (meters) *</u>			
BV005	6900		Anorthositic, chromite-rich gabbro	
BV108	6780		Anorthositic, chromite-rich gabbro	
BV202	6550		Gabbronorite	
BV204	6090		Gabbronorite	
BV107	6010		Norite	
BV014	5600		Gabbronorite	
BV106	3100		Anorthosite	
BV007A	3050		Pyroxenite	
BV105	2690		Norite	
BV104	2100		Pyroxenite	
BV011B	2000		Chromite	
BV103	1995		Pyroxenite	
BV009D	1500		Bronzite	
BV200	1380		Harzburgite	
BV102	1280		Dunite	
BV009A	1220		Harzburgite	
BV203	"Marginal Zone"		Norite	

*Based on: South African Committee on Stratigraphy (SACS) (1980). Compiler, L.E. Kent. Geological Survey of South Africa Handbook, vol. 8, 690 pp.

Kiglapait Igneous Intrusion Samples			
Sample	Zone	PCS	Rock Name
KI-3173	UBZ	99.99	Ferro-syenite
KI-4084	UZ	99.985	Ferro-syenite
KI-4062	UZ	99.975	Ferro-syenite
KI-4144	MUZ	94.4	Gabbro
KI-3371	LUZ	91	Gabbro
KI-3710	LZ	72	Troctolite