Announcements

• Reading: none!
• Tents and food groups at the end
Di-An binary
Layered Mafic Intrusions: crystallization and differentiation

<table>
<thead>
<tr>
<th>Name</th>
<th>Age</th>
<th>Location</th>
<th>Area (km²)</th>
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<tbody>
<tr>
<td>Bushveld</td>
<td>Precambrian</td>
<td>S. Africa</td>
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<td>Dufek</td>
<td>Jurassic</td>
<td>Antarctica</td>
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<td>NW Terr. Canada</td>
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<td>Zimbabwe</td>
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<td>Skaergård</td>
<td>Eocene</td>
<td>East Greenland</td>
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exposed in continents, many associated with flood basalts, generally Precambrian.
The form of a typical LMI

Lopolith: concordant intrusion, fairly flat upper surface

Figure 12-1. From Irvine and Smith (1967), In P. J. Wyllie (ed.), Ultramafic and Related Rocks. Wiley. New York, pp. 38-49.
Cumulate textures

- Caution! texture vs. paragenesis

**Figure 3-14.** Development of cumulate textures. **a.** Crystals accumulate by crystal settling or simply form in place near the margins of the magma chamber. In this case plagioclase crystals (white) accumulate in mutual contact, and an intercumulus liquid (pink) fills the interstices. **b.** Orthocumulate: intercumulus liquid crystallizes to form additional plagioclase rims plus other phases in the interstitial volume (colored). There is little or no exchange between the intercumulus liquid and the main chamber. After Wager and Brown (1967), *Layered Igneous Rocks*. © Freeman. San Francisco.
Figure 3-14. Development of cumulate textures. c. Adcumulates: open-system exchange between the intercumulus liquid and the main chamber (plus compaction of the cumulate pile) allows components that would otherwise create additional intercumulus minerals to escape, and plagioclase fills most of the available space. d. Heteradcumulate: intercumulus liquid crystallizes to additional plagioclase rims, plus other large minerals (hatched and shaded) that nucleate poorly and poikilitically envelop the plagioclases. After Wager and Brown (1967), *Layered Igneous Rocks*. © Freeman. San Francisco.
Layering

**layer**: any sheet-like cumulate unit distinguished by its compositional and/or textural features

- **uniform** mineralogically and texturally homogeneous
- **non-uniform** vary either along or across the layering
  - **graded** = gradual variation in either
    - **mineralogy**
    - **grain size** - quite rare in gabbroic LMI
Uniform Layering

Uniform chromite layers alternate with plagioclase-rich layers, Bushveld Complex, S. Africa.
Economic value of layered intrusions

4-10 g/t
Pt $881/ oz  Au $439 / oz
Graded Layers

Possible causes of rhythmic modal layering

- Periodic large-scale convective overturn of the entire cooling unit
- Reinjection of more primitive magma
- In situ crystallization
- Density currents along walls and floor

The Room Problem: Assimilation
Melting on a phase diagram

• How does the melt composition/solid composition evolve?