Anorthosites

Reading:

Winter Chapter 20, p. 401-407

Anorthosites

- Plutonic rocks with over 90% plagioclase
  - No known volcanic equivalents
- Highly felsic nature and their location in continental areas they share with granitoid rocks
- The felsic mineral, however, is a calcic plagioclase, which, along with associated high-temperature mafic minerals, suggests a stronger similarity to basaltic rocks

Types of Anorthosites

Ashwal (1993) listed six major types or anorthosite occurrences:

1. Archean anorthosite plutons
2. Proterozoic "massif-type" anorthosite plutons
3. Centimeter-to-100m thick layers in layered mafic intrusions
4. Thin cumulate layers in ophiolites/oceanic crust
5. Small inclusions in other rock types (xenoliths and cognate inclusions)
6. Lunar highland anorthosites

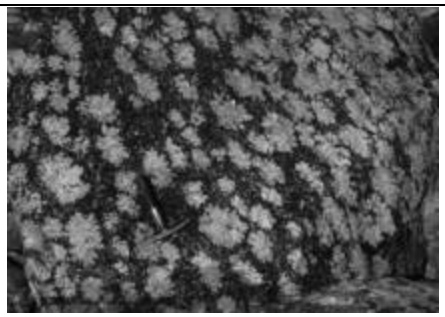


Figure 20-1a. a. "Snowflake" clusters of plagioclase crystals from the Fiskenæsset complex, W. Greenland. Myers (1985) Stratigraphy and structure of the Fiskenæsset complex, West Greenland. *Grønl. Geol. Unders. Bull* 150. Photograph courtesy John Myers. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

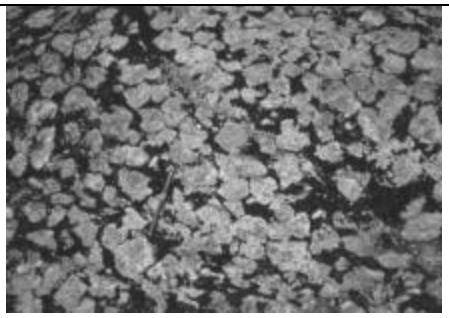
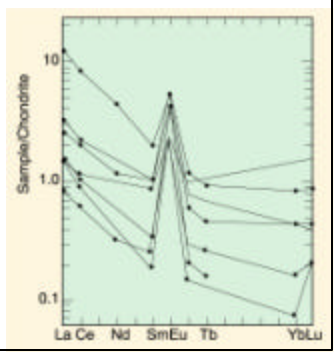
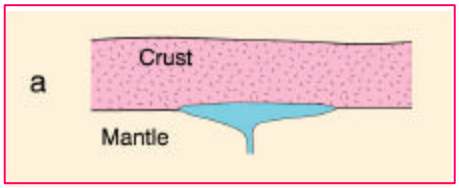


Figure 20-1a. a. Typical texture of Archean anorthosite. From the Fiskenæsset complex, W. Greenland. Myers (1985) Stratigraphy and structure of the Fiskenæsset complex, West Greenland. *Grønl. Geol. Unders. Bull* 150. Photograph courtesy John Myers. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

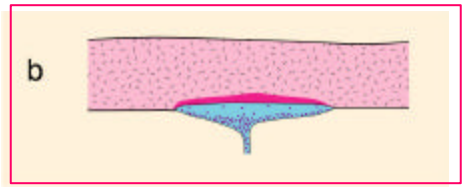
Figure 20-2. Chondrite-normalized rare earth element diagram for some typical Archean anorthosites from the Bad Vermillion (Ontario) and Fiskenæsset (Greenland) bodies. Data from Seifert *et al.* (1997) *Can. J. Earth Sci.*, 14, 1033-1045; Simmons and Hanson (1978) *Contrib. Mineral. Petrol.*, 66, 19-135; and Ashwal *et al.* (1989) *Earth Planet. Sci. Lett.*, 91, 261-270. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.





a. Mantle-derived magma underplates the crust as it becomes density equilibrated.

Figure 20-2. Model for the generation of Massif-type anorthosites. From Ashwall (1993) *Anorthosites*. Springer-Verlag. Berlin. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.



b. Crystallization of mafic phases (which sink), and partial melting of the crust above the ponded magma. The melt becomes enriched in Al and Fe/Mg.

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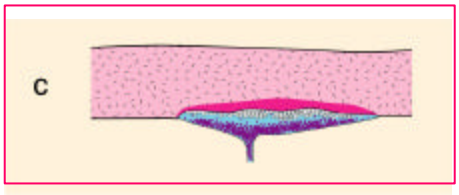

c. Plagioclase forms when the melt is sufficiently enriched. Plagioclase rises to the top of the chamber whereas mafics sink.

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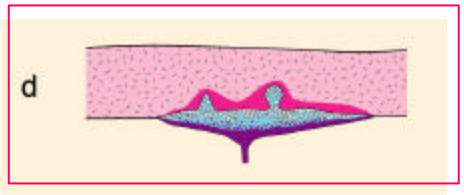

d. Plagioclase accumulations become less dense than the crust above and rise as crystal mush plutons.

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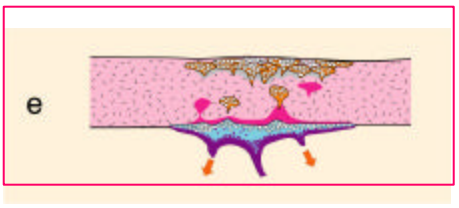

e. Plagioclase plutons coalesce to form massif anorthosite, whereas granitoid crustal melts rise to shallow levels as well. Mafic cumulates remain at depth or detach and sink into the mantle.

Figure 20-2. Model for the generation of Massif-type anorthosites. From Ashwall (1993) *Anorthosites*. Springer-Verlag. Berlin. Winter (2001) An Introduction to Igneous and Metamorphic Petrology. Prentice Hall.

Figure 20-2. Model for the generation of Massif-type anorthosites. a. Mantle-derived magma underplates the crust as it becomes density equilibrated. b. Crystallization of mafic phases (which sink), and partial melting of the crust above the ponded magma. The melt becomes enriched in Al and Fe/Mg. c. Plagioclase forms when the melt is sufficiently enriched. Plagioclase rises to the top of the chamber whereas mafics sink. d. Plagioclase accumulations become less dense than the crust above and rise as crystal mush plutons. e. Plagioclase plutons coalesce to form massif anorthosite, whereas granitoid crustal melts rise to shallow levels as well. Mafic cumulates remain at depth or detach and sink into the mantle. From Ashwall (1993) *Anorthosites*. Springer-Verlag. Berlin; Winter (2001)