Libby Montana Vermiculite Mine

W.R. Grace

Location of Facilities

- Location of screening facility
- Location of mill/transfer facility
- Location of expansion facility
Libby Vermiculite Mine
Rainy Creek Pluton
Definitions – rock names

- Fenite – narrow hydrothermally altered zone of Na-metasomatism, hydrolysis, and oxidation, with increased sodium, hydrous silicates and hematite
- Biotitite – rock composed almost entirely of biotite
- Syenite – plutonic rock w/ low Quartz, $10^{P} < P / (A + P) < 35$
Minerals

• Biotite – $K(Mg,Fe^{2+})_3(AlSi_3O_{10})(OH)_2$
• Hydrobiotite – formula about halfway in between Bt and Vermiculite, considered to be a high T alteration product of Biotite (Boettcher, 1966)
• Vermiculite –
  $(Mg,Ca)_{0.3}(Mg,Fe^{3+},Al)_3(Al,Si)_4O_{10}(OH)_4 - 8H_2O$
  originated by leaching of biotite by ground waters
  (removal of alkalisis and oxidation of Fe$^{2+}$ to Fe$^{3+}$
  Boettcher, 1966)
• Amphiboles – useless byproduct (from hydrothermal alteration of pyroxene), more later
W.R. Grace wanted the vermiculite

- Mostly in Biotitite
- Amphibole asbestos is intimately associated with vermiculite, but is useless
Rainy Creek Pluton
Sheet silicate structures

Vermiculite Structure
Expansion Process
- Vermiculite was shipped all over the US for processing

- Vermiculite is heated for a few seconds to 1100°C
- Water present in vermiculite structure vaporizes to steam and forces layers of sheet silicate apart
- This creates the usable product
Unexpanded and Expanded Vermiculite
Location of Facilities

Explanation

- Libby, MT
- W.R. Grace vermiculite mine
- U.S. Hwy 2
- MT Hwy 37

1. Location of screening facility
2. Location of mill / transfer facility
3. Location of expansion facility

Figure 3
Uses of Expanded Vermiculite

- Insulation
- Fireproofing
- Bulking agents
- Absorbents
- Soil amendments
- Industrial fillers
- Packing material
Libby Amphibole analyses – note Fe$^{3+}$ and Fe$^{2+}$

Naming Amphiboles

• Why should we care?
• Only reibekite, grunerite, anthophyllite, actinolite and tremolite amphiboles are regulated as asbestos by the US EPA
• Non-mineralogists call Libby amphiboles tremolite; are they, really?
• No, they are other amphiboles called winchite or richterite
• Other amphibole asbestos minerals are just as bad, but are not regulated!
Naming Amphiboles

• How is it done?
• Follow specific rules for assigning elements in chemical analysis of an amphibole to different sites in the formula
• Leake, et al., 1997, Nomenclature of amphiboles..., American Mineralogist, 82, 1019-1037.
Amphibole Formula

\[ AB_2C_5T_8O_{22}(OH)_2 \]

\[(Na,K)_{0-1}(Ca,Na,Fe,Mg)_2(Mg,Fe,Al)_5(Si,Al)_8O_{22}(OH,F)_2 \]

large  medium  small  tetrahedral

Libby Amphiboles

1. \((Na_{1.14}K_{.13})(Ca_{1.25}Na_{.73})(Mg_{4.24}Fe^{3+}_{.41}Fe^{2+}_{.30})Si_{8.0}O_{22}(OH,F)\)

2. \((Na_{3.2}K_{.19})(Ca_{1.12}Na_{.85})(Mg_{4.43}Fe^{3+}_{.34}Fe^{2+}_{.18})Si_{8.0}O_{22}(OH_{1.63}F_{.37})\)
Naming sodic-calcic amphiboles per Leake, et al., 1997
Mineralogist’s Names for Libby Amphiboles

- They are sodic-calcic amphiboles
- Some classify as richterite
- Some classify as winchite

- They are not even in the same group as tremolite (a calcic amphibole), which is the name used in the media
Selections from Libby, Montana video

- Big Sky Pictures
- Produced, directed and edited by Drury Gunn Carr & Doug Hawes-Davis
Libby, Montana Asbestos Cleanup Reaches Major Milestone With Mountaintop Park

In this April 28, 2011 photo, D.C. Orr, a city councilman in Libby, Mont., stands in the middle of a storage area, where bark and wood chips contaminated with undetermined levels of lethal asbestos were stored. Test results from huge piles of woodchips that were being sold from a Montana Superfund site for use in landscaping show they contain minimal levels of asbestos, according to a report Friday Jan. 13, 2012. The findings appear to offer a rare bit of relief for this town of Libby, where wide