Stillwater Complex (Mountain View Section), Montana Petrographic Suite

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(1984, revised by Kurt Hollocher 1999)

Introduction

The Stillwater complex is one of the world's major layered ultramafic-gabbroic intrusive complexes. It is Precambrian in age (2700 my) and is exposed along the northern edge of the Beartooth Mountains in southern Montana, just northeast of Yellowstone Park. It is exposed along strike for 44 km and the exposed thickness is nearly 6 km. The upper units of the pluton have been removed by erosion.

The complex is probably best known for its banded chromitites. With the discovery of the platinum-bearing reef, (somewhat comparable to the Merensky Reef of the Bushveld Complex) and subsequent exploration, there has been considerable re-thinking of the entire complex. The platinum-bearing reef is known as the J-M Reef or the Howland Reef. (See Todd, et. al. 1982).

The work of Todd, et. al., indicates two magmas. The first, yielded the ultramafic series (Figures 1 and 2) including the 15 cyclical bands which include chromite. The second magma yielded the layered series, which is made up of six major units (megacyclic units). The layers in the ultramafic series include repetitions of chromite + olivine, orthopyroxenite, and anorthosite. The layered series includes repetition of norite, gabbro, troctolite, and anorthosite. The platinum-bearing reef is located at the top of the lowest layer or the base of the second layer in the layered series (Figure 2). The units in the layered series are much more leucocratic than the terminology suggests. The norites are plagioclase-rich, and gabbro, in field and core analysis, consists of the appearance of small quantities of clinopyroxene in the norite.

This suite includes representative lithologic types found in the complex. It is not a detailed stratigraphic succession. Besides the rock types found in the typical chromite-bearing sequences and in the upper layered series, basal norite and basal orthopyroxenite are included, as is the cordierite hornfels that occurs just below the base of the complex. A sulfide-rich hornfels immediately below the base of the complex, and a small specimen containing sulfides from the J-M Reef are also included.

Marvin Ratcliff, consulting geologist in Helena, Montana, has worked extensively on the complex in the past few years. He provided the technical assistance we needed in selecting the collecting sites. In addition, he actually provided the basal norite material - which he had collected and checked to distinguish from the underlying hornfels, and the sulfide-bearing sample from J-M zone. His assistance was invaluable.

Specimens and Locations

1) Cordierite hornfels in the contact metamorphic zone. Nickel Camp above the Minneapolis Adit, E and below Mountain View Mine.

2) Contact metamorphic hornfels with massive sulfides (pyrrhotite-chalcopyrite). From just below the base of the complex at the Nickel Camp (Figure 1).

3) Quartz monzonite pluton near the base of the complex. From a few hundred yards along the road from Nickel Camp toward the Mountain View Mine road (there are coarser and finer facies of this body).

4) Chromite-olivine rock, from an olivine layer of a typical chromite repeat sequence. Mountain View Mine.

5) Olivine Cumulate layer.

6) Orthopyroxenite.

7) Orthopyroxenite with oikocrysts of olivine.

8) Anorthosite with oikocrysts of pyroxene.

9) Basal fine grained (chilled?) norite. Nickel Camp area. Material identified by and donated by Marvin Ratcliff.

10) Sulfides in troctolite or related rock from the J-M Reef. Specimens provided by Marvin Ratcliff.

11) Fine layered anorthosite above the "barren" troctolite layer on the mine road above the Minneapolis Adit. Most of the layers in the strongly layered anorthosites, including those commonly photographed, are several inches thick. We selected a particularly thin-layered rock in order to get both light and dark layers in a single hand specimen.

12) Upper "barren" troctolite. Although mineralogically identical to the J-M Reef troctolite, there are no associated sulfides.

13) Troctolite from the J-M Reef zone.

14) Fine spotted anorthosite. Many anorthosites are spotted (mafic mineral clusters), many with much larger and darker spots. This material was sampled to provide a hand specimen which would show spotting.

15) Norite from below the J-M Reef. This is an especially dark variety, and is not really typical.

16) Leucocratic norite from below the J-M Reef. This is much more typical of the norites, certainly in the lower part of the layered series.

17) Leucocratic gabbro. You will have to look for the monoclinic pyroxenes. Orthopyroxenes are most abundant. From quite close below the J-M Reef.

18) Orthopyroxenite with large crystals of augite. From upper part of the Upper Orthopyroxenite in the upper part of the Ultramafic Series.

19) Very coarse mafic crystals from troctolite layer of the J-M Reef.

Samples 4 to 8 are typical lithologies of a "chromite" repeat layered unit. Samples 11 and 12 were collected from outcrops on the mine road above the Minneapolis Adit. Samples 13, 14, 15, l6, 17, and 19 are from the dump of the Minneapolis Adit, from materials designated for collection by Mr. Ratcliff.

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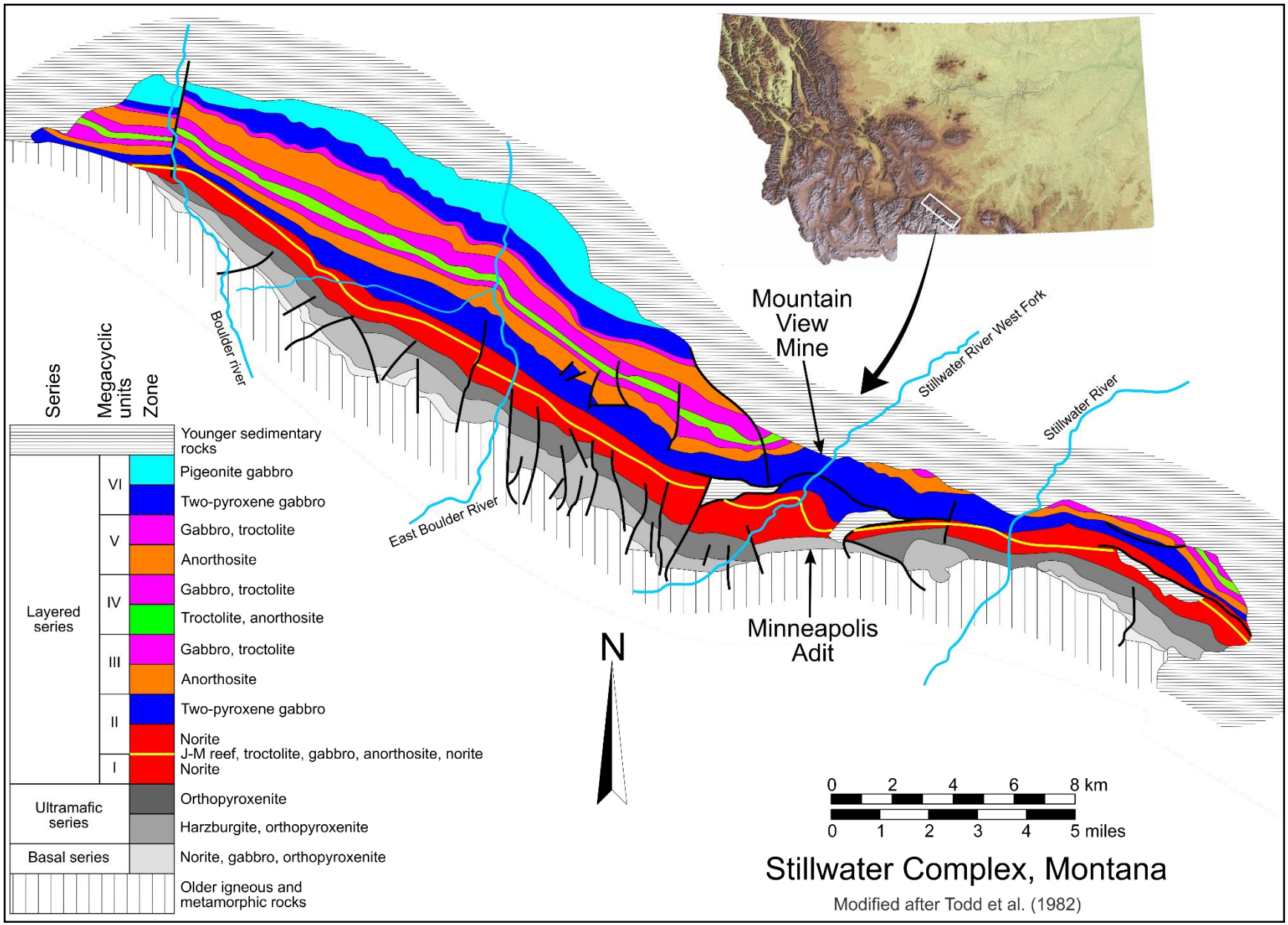
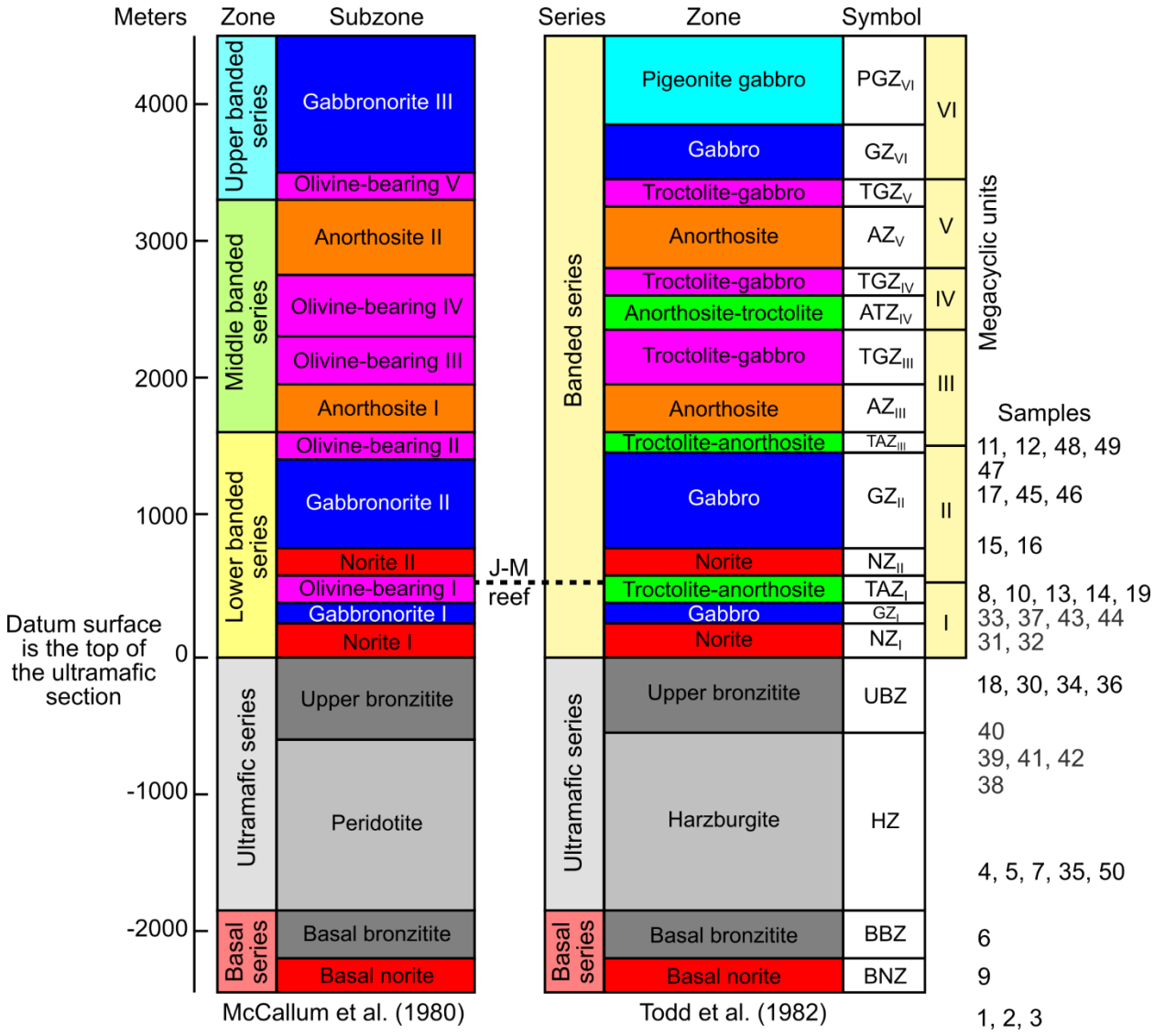

Series
Megacyclic units
Zone
Younger sedimentary rocks
Layered series
VI
Pigeonite gabbro
Two-pyroxene gabbro
V
Gabbro, troctolite
Anorthosite
IV
Gabbro, troctolite
Troctolite, anorthosite
III
Gabbro, troctolite
Anorthosite
II
Two-pyroxene gabbro
Norite
I
J-M reef, troctolite, gabbro, anorthosite, norite
Norite
Ultramafic series
Orthopyroxenite
Harzburgite, orthopyroxenite
Basal series
Norite, gabbro, orthopyroxenite
Older igneous and metamorphic rocks
Boulder river
East Boulder River
Mountain View Mine
Stillwater River West Fork
Stillwater River
Minneapolis Adit
N
0 2 4 6 8 km
0 1 2 3 4 5 miles
Stillwater Complex, Montana
Modified after Todd et al. (1982)


Meters
Zone
Subzone
Series
Zone
Symbol
4000
3000
2000
1000
0
-1000
-2000
Datum surface is the top of the ultramafic section
Upper banded series
Middle banded series
Lower banded series
Ultramafic series
Basal series
Gabbronorite III
Olivine-bearing V
Anorthosite II
Olivine-bearing IV
Olivine-bearing III
Anorthosite I
Olivine-bearing II
Gabbronorite II
Norite II
Olivine-bearing I
Gabbronorite I
Norite I
Upper bronzitite
Peridotite
Basal bronzitite
Basal norite
J-M reef
Banded series
Ultramafic series
Basal series
Pigeonite gabbro
Gabbro
Troctolite-gabbro
Anorthosite
Troctolite-gabbro
Anorthosite-troctolite
Troctolite-gabbro
Anorthosite
Troctolite-anorthosite
Gabbro
Norite
Troctolite-anorthosite
Gabbro
Norite
Upper bronzitite
Harzburgite
Basal bronzitite
Basal norite
PGZVI
GZVI
TGZV
AZV
TGZIV
ATZIV
TGZIII
AZIII
TAZIII
GZII
NZII
TAZI
GZI
NZI
UBZ
HZ
BBZ
BNZ
VI
V
IV
III
II
I
Megacyclic units
Samples
11, 12, 48, 49
47
17, 45, 46
15, 16
8, 10, 13, 14, 19
33, 37, 43, 44
31, 32
18, 30, 34, 36
40
39, 41, 42
38
4, 5, 7, 35, 50
6
9
1, 2, 3
McCallum et al. (1980)
Todd et al. (1982)