Lithological, Structural and Metamorphic Analysis for Study Area #10 Southeast of Creighton, Saskatchewan

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Abstract

A relatively small section (~5.7 x 10^{-1} km^2) of the Amisk Group located southeast of Creighton, Saskatchewan was analyzed and later mapped over a period of three days in September, 2015. In total twenty-eight stations were examined for lithological, structural, metamorphic and economic geological data. As a result, six supracrustal units and two intrusive units were interpreted with many stations show relationships between structural faulting and shearing. Potential economically valuable minerals make be associated with rhyolitic volcanics and volcaniclastics located in the west of the study area.

1 - Introduction and Location

The Amisk Group located in near the region of Flin Flon, Manitoba and Creighton, Saskatchewan consists largely of thoeiitic basalts, volcaniclastic rocks, and an economically important, but volumetrically minor rhyolitic volcanic and volcaniclastic rocks (Bailey and Gibson, 2004). A pre-determined section of this area was described and later mapped to better understand geologic relationships. The data in this report was collected over the period of three days between September 2 - 4, 2015 by Mollica Bhattacharjee, Adam Edwards, Brodie Stroh and the author. The study area is located southeast of Creighton, Saskatchewan and southwest of Flin Flon, Manitoba and considers an area of roughly 5.7 x 10^{-1} km^2. As such, this was assigned as Study Area #10 and is crossed in the northwest of the areas of study by Highway 167. In total, twenty-eight stations were examined, analyzed and mapped. Stations were recorded from UTM co-ordinates using the provided GPS device. As such, station numbers are based on the waypoint function from the GPS unit. Because of this the assigned station numbers can be confusing and are best not to be considered as sequential as many false waypoints were mistakenly taken in team member's bags during traverses between stations. At each station, several geological and geographic were considered such as, outcrop character, lithologies, structural information, metamorphic features and possible economic properties. Along with this report, a 1:1700 scale map was produced and completed on September 6, 2015 that showcased some of the more

substantial geological data of the area A copy of this map, albeit of lesser quality, has been attached as an included figure.

2 - Regional Geological Setting

The Amisk Group is a part of the greater Flin Flon Greenstone Belt, which is part of the Trans-Hudson Orogen (1.9 to 1.8 Ga) (Bailey and Gibson, 2004). This Paleoproterozoic orogen is understood to have formed as consequence of collisions between the Archean Superior and Rae-Hearne cratons, and the intra-oceanic terranes joining them (Bailey and Gibson, 2004). More specifically, the Amisk Group is comprised of four tectono-stratigraphic assemblages, which include from oldest to youngest: evolved arc (1.92 to 1.9 Ga), an undated oceanic plateau, oceanic floor (1.9 Ga) and juvenile oceanic arc (1.9 to 1.88 Ga) (Bailey and Gibson, 2004). Economically important volcanigenic massive sulphides are hosted in the juvenile oceanic arc assemblage. The Amisk Group is unconformably overlain by metasedimentary sandstones and conglomerates of the Missi Group and is intruded by numerous dykes (Stauffer et al., 1975). The Amisk Group experienced intense folding and faulting during the Hudsonian Orogeny and encompassed three separate phases of deformation and several phases of faulting (MacLachlan et al., 2002; Stauffer et al., 1975; Syme et al., 1976).

3 - Geology of the Map Area

3.1 - Description of Rock Units

A total of six supracrustal units were classified in this study. Intrusive rock units include the Boundary Intrusions that were found at least two stations and various dykes that were predominantly classified as diabase. Several units are repeated and/or have temporal relationships that are difficult to classify. As such, units will be discussed in relation to younging directions, which are statistically consistent throughout the study area. The following sections expand on the lithological characteristics of each unit.

3.1.1 - Supracrustal Rocks

Based on statistical relationship of younging direction that is roughly towards the southeast (~140º) the first unit to be discussed is referred to Amygdaloidal Pillow Basalt Unit on the map. This unit was observed primarily in the western portion of the mapping area with two occurrences at stations 119 and 120 that are found in the southeastern portion of the map (Figure 6.1). This unit consists of amygdules composed primarily of quartz and feldspar. The matrix of this unit is too fine-grained to accurately determine, but is assumed to consist primarily of mafic

minerals such as plagioclase and pyroxene. Pillows are frequently deformed and elongated (Figure 6.6). Younging indicators range from around ~120º up to ~170º in a few instances. This unit is occasionally vesicular, but generally this is localized. This unit is separated by a relatively thin layer of rhyolite and millrock at Station 100. This will be discussed more thoroughly later in this section. Trace amounts of sulphides were found at Station 111 (Figure 6.1). Diabase dykes, which is to be discussed in a later section, is found in this unit at stations 100 and 102.

The second unit is the Rhyolite Unit that is located in the western portion of the map area and was observed at stations 100 and 123. This relatively thin and narrow unit was mapped to separate two Amygdaloidal Pillow Basalt units that extends beyond the study area. Upon further observation, this unit is quite extensive in the west beyond the mapping boundaries. This unit appears to be associated with what will be referred to as the Millrock Unit, especially when the outcrop to the west is taken into consideration. This unit is blueish-grey in Station 123 and reddish-orange to yellowish-red in Station 100. The reddish-orange constituent is possibly the flow banded facies regarded as Type 2 of the Myo Member Rhyolites by Bailey and Gibson (2004).

Associated with the Rhyolite Unit is the Millrock Unit. Bailey and Gibson (2004) describe the Millrock Member as being made up of "…heterolithic to monolithic breccias, mafic and felsic volcaniclastic rocks, aphyric to quartz- and feldspar-phyric rhyolite flows, domes and cryptodomes and associated autoclastic volcaniclastic rocks." This unit is widespread and well exposed to the west of the map area, but a small poorly-exposed outcrop was observed in the southeast portion of Station 100 with a sharp to inferred contact with the Amygdaloidal Pillow Basalt Unit and an inferred contact with the millrock that is better exposed at Station 123 (Figure 6.5).

A relatively narrow unit of the proceeding unit mapped as Flow Basalt was mapped between the first unit discussed and the next unit (Figure 6.1). This unit is far more pervasive in a relatively younger unit found in the eastern portion of the study area but will be discussed here. The relatively thinness in width is based on occurrences of the unit in stations 106, 110, 111 and 112; and absence in nearby stations 104 to the west and 109 to the east. Further, this unit would appear to 'pinch-out' to the north at Station 112. To the east, this unit was observed in part or wholly at stations 113, 114, 115, 116, 117, 119 and 120. A second narrow area has been mapped in the southwest portion of the map (Figure 6.1). It is correlative between the stations 102 and 104 and appears to be associated with shearing in the area (Figure 6.2). Way-up for the massive

flow basalt is difficult to interpret as textures are rare to absent. The lithology is probably similar to that found in the Hidden Formation, being aphanitic to fine-grained to rarely amygdaloidal and composed largely of mafic minerals, namely pyroxene and plagioclase (MacLachlan et al., 2002). Trace sulphides were observed at Station 110. In the east, this unit is associated with a considerable amount epidote alteration and was observed at all the above stations except stations 113, 118 and 119.

The fifth unit is found the central third of the map area and also found in outcrops in the east. This unit is referred to on the map as Amygdaloidal Flow Basalt. It is similar in lithology as the Flow Basalt unit, however this unit consists of abundant amygdules composed primarily of quartz and feldspar. Diabase dykes are fairly common throughout. Boundary intrusives were observed at Station 095. Epidote alteration is relatively common in the north. Trace sulphides were observed only at Station 090.

The final mapped unit is labeled Flow Top Breccia. This unit was only observed at Station 113 (Figure 6.3). Their is an abrupt contact with the Flow Basalt unit that anomalously returns to Flow Top Breccia. Due to relatively poor exposure beyond the stations scope, the extent and relationship of this unit and to adjacent units is not well understood and as such, is reflected on the map (Figure 6.1).

3.1.2 - Intrusive Rocks

The intrusive rocks observed in this study can be broadly categorized into two units: diabase dykes and Boundary Intrusions. Diabase dykes were found in nine stations (Figure 6.1). Contact aureoles were common, though not widespread, rarely extended further than ~0.15 m and did not exceed greenschist facies. Mineralogically, the diabase dykes are composed of fine-grained mafic minerals such as pyroxene and plagioclase and ranged from aphanitic to phaneritic in some cases. The thickness of dykes ranges from as small as around ~0.06 m upwards to ~0.60 m, but on average were typically ~0.25 m. Vesicles were observed in the centre of the diabase dyke found at Station 121. Weathered samples were reddish-brown, while fresh cuts were darker greys to greyish-browns. Dykes commonly were observed to have statistically similar strikes throughout the study area, especially in relation to proximal shearing.

Boundary intrusives were recorded at two stations. At Station 095, this unit occurs as a relatively large plutonic structure and is inferred to extend beyond the exposed outcrop easterly (Figure 6.1). Compositionally, this coarse-grained pluton is comparable to that of a granodiorite.

That is, being composed primarily felsic minerals such as quartz, plagioclase and alkali feldspar with small amounts of amphibole and biotite mafic minerals. Its contact with the surrounding Amygdaloidal Flow Basalt is primarily sharp with some evidence for contact metamorphism (Figure 6.4). The Boundary Intrusion unit found at Station 114 was only observed in a poorly exposed dyke that only extended distally a few metres. This fine-grained dyke is ~0.5 m wide and contains abundant subhedral to anhedral felsic minerals such as quartz and alkali feldspar similar to that discussed by Syme and Forester (1976).

3.2 - Structural Geology

The area of study shows abundant faulting and shearing. Orientations for these structural features, along with conjugate fracture sets, mineral lineations and quartz veins were recorded at each station in order to obtain any valuable statistical relationships between these features. It the west, major faults and shear zones share similar trends, typically striking ~330º on average. In the east, they trend between roughly 180º and 330º. Kinematic indicators such as, sigma quartz, tension gashes, CS fabric typically displayed dextral displacement, but on a few occasions sinistral movement was observed. At Station 100, significant faulting led to 17 m dextral displacement of a diabase dyke.

3.3 - Metamorphism

Most of the rock units in the study area may be considered to be metavolcanic, though the degree of metamorphism is largely low with deformational foliatons often difficult to observe. Phyllitic textures were not uncommon, especially in fresh cut samples. Thus, the strongest metamorphism in the study area was found in contact aureoles associated with intrusives, such as diabase dykes, and deformation related to shearing, the latter being the most common due to significant amount of shearing that occurs throughout the map area. Metamorphism in the area does not exceed greenschist facies and textures ranges from predominately phyllitic to moderately schistose. Chloritization is relatively common (Stauffer et al, 1975).

3.4 - Economic Geology

Economic considerations in the mapping area pertain to hydraulic mineralization potentially found in quartz veins associated with shearing and volcanigenic massive sulphide deposits that are related to rhyolitic volcanic and volcaniclastic rocks (Stauffer et al, 1975; Bailey and Gibson, 2004). The potential for volcanigenic massive sulphide deposits is thus restricted to the Rhyolite and Millrock units found in the western edge of the mapping area (Figure 6.1).

More significant and better exposed outcrops of possible volcanigenic massive sulphide deposits can be found further west outside of the study area.

4 - Summary

Six supracrustal and two intrusive geologic units were observed at twenty-eight stations found throughout the mapping area for this report. The three most volumetrically significant being the supracrustal Flow Basalt, Amygdaloidal Flow Basalt and Amygdaloidal Pillow Basalt units. Minor rhyolitic volcanics and volcaniclastics were found in the west. Diabase dykes were common while Boundary intrusions were only observed at two stations. The orientational relationship with diabase dykes with faulting which is on average ~330º would be to be significant. Metamorphism is most significant in shear zone and in contact aureoles surrounding most dykes.

5 - References

Bailey, K. A. and Gibson, H.L. (2004): A field description of the Myo Rhyolite, Flin Flon and Creighton, Saskatchewan; *in* Summary of Investigations 2004, Volume 2, Saskatchewan Geological Survey, Sask. Industry Resources, Misc. Rep. 2004-4.2, CD-ROM, Paper A-1, 11p.

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Syme, E. C., and Forester, R. W. (1976): Petrogenesis of the Boundary intrusions in the Flin Flon area of Saskatchewan and Manitoba; *Canadian Journal of Earth Sciences*, 14:444-455, 10.1139/e77-044. 12p.

6 - Figures

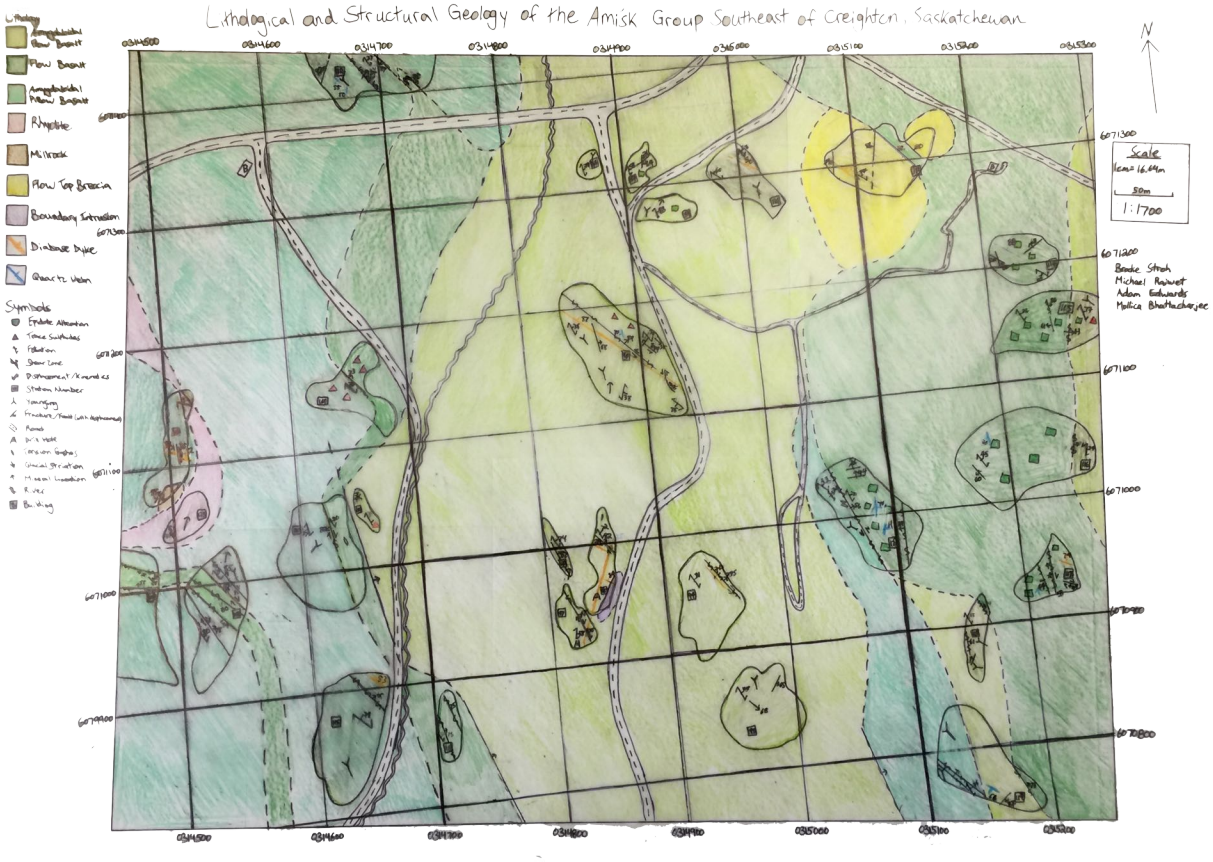

Figure 6.1 – Map digitally modified from photograph of map to enhance colouring and presentation of this report.

Figure 6.2 – Sharp contact between highly deformed Flow Basalt and relatively undeformed Amygdaloidal Pillow Basalt units at Station 111.

Figure 6.3 – Flow Top Breccia unit observed at Station 113

Figure 6.4 – Tension gashes between contact of Boundary Intrusion pluton and Amygdaloidal Flow Basalt country rock at Station 095.

Figure 6.5 – Millrock unit observed south of Station 100.

Figure 6.6 – Deformed pillow structures observed in a larger shear zone at Station 119. Younging was interpreted to be ~171º.