Geology of the hanging wall to the Schist Lake and Mandy volcanogenic massive sulphide deposits, Flin Flon, Manitoba, Canada

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Summary

The Paleoproterozoic Glennie–Flin Flon Complex is part of the southeastern Reindeer Zone of the Trans-Hudson Orogen and contains 27 known volcanogenic massive sulphide (VMS) deposits. Two of these, the Schist Lake and Mandy deposits, are located on the western edge of the Northwest Arm of Schist Lake in northwestern Manitoba, approximately 4 km southeast of the main Flin Flon VMS deposits, and are currently inactive.

The study area is located within the Flin Flon arc assemblage and is bounded to the west by a north-trending fault separating the Hidden formation from the Louis formation, and to the east by the north-trending Cliff Lake Fault. From the west shoreline of the Northwest Arm of Schist Lake to Carlisle Lake there is a sequence of dominantly mafic volcaniclastic rocks, with lesser basaltic flows. This sequence could be equivalent to the hangingwall stratigraphy for the Schist Lake and Mandy deposits, which lie just to the east under Schist Lake, with younging directions consistently to the west, depending on the displacement on the Mandy Road faults (Figure 1).

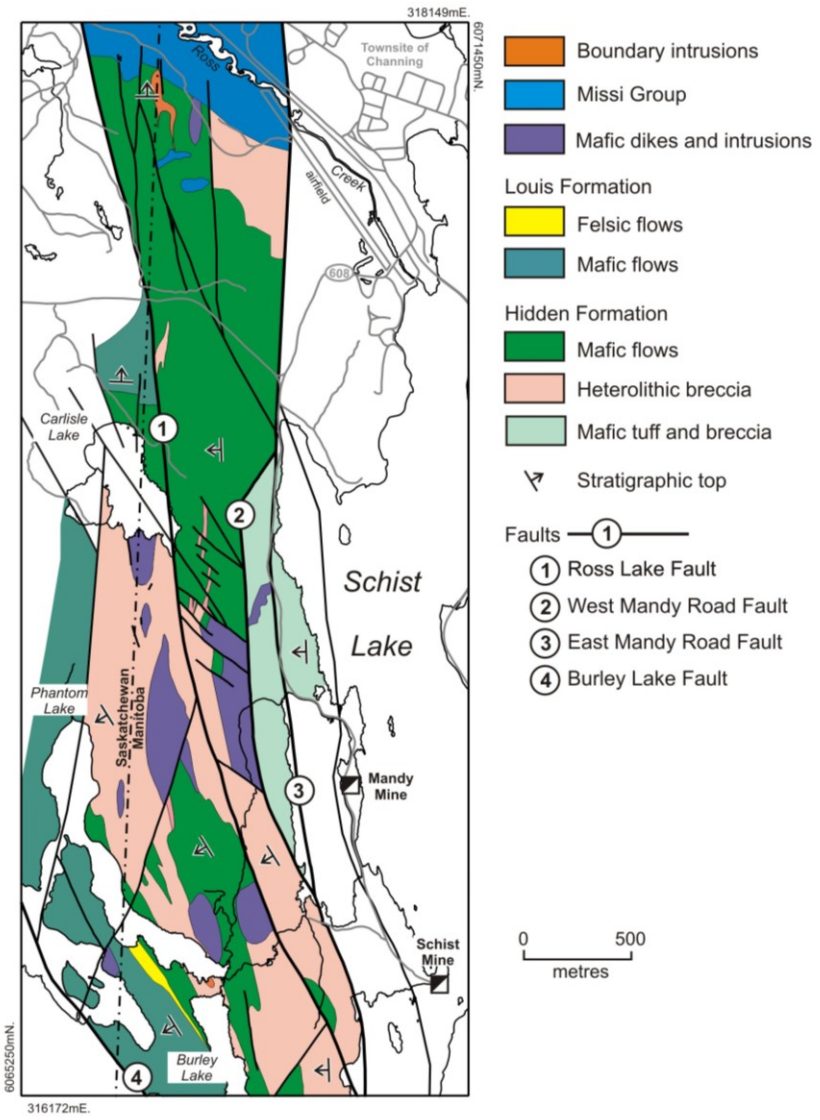

Figure 1: Simplified bedrock geology of the Schist Lake–Mandy mines area, Flin Flon, Manitoba (modified from Simard, 2006).

The presence of a mafic tuff unit on both the east and west side of the East Mandy Road Fault (with no change in orientation across the fault) suggests that this fault has not significantly offset strata in the area. Similarly, the contact between the tuff and the overlying basaltic flows does not appear to be significant offset. Consequently the volcanic rocks that overlie the Schist and Mandy deposits are interpreted to form a continuous homoclinal sequence and to be the stratigraphic hanging wall to the Schist Lake and Mandy deposits. The thick succession of mafic volcaniclastic rocks overlying the Schist Lake and Mandy deposits, which abruptly end to the north and south along strike, are interpreted to have been deposited in, and define, a synvolcanic subsidence structure. The margins of this structure, when traced downwards into the footwall, define a structural corridor that could encompass the Schist Lake and Mandy deposits suggesting these were long-lived, reactivated structures, used as magma and hydrothermal fluid pathways, and related to the genesis of the ore deposits below.

Introduction

The volcanic rocks near the town of Flin Flon host current (Callinan, Triple 7 and Trout Lake) and past-producing (Flin Flon, Schist Lake and Mandy) VMS deposits. Collectively, these

deposits total more than 90 million tonnes and constitute one of the world's largest massive sulphide districts in the Proterozoic (Bailes and Syme, 1989; Syme et al., 1999). Rocks that host the Schist Lake and Mandy deposits are currently assigned to an undivided package of volcanic rocks that lies just east of the Mandy Road faults. Volcanic rocks that lie west of the Mandy Road Faults, and potentially constitute the hangingwall strata to the Schist Lake and Mandy VMS deposits, have been correlated with the volcanic rocks of the Hidden and Louis formations (Bailes and Syme, 1989; Simard, 2006; Simard and Creaser, 2007). The Hidden and Louis formations form the lower and upper units, respectively, within the hangingwall to the Flin Flon, Callinan and Triple 7 VMS deposits (DeWolfe et al., 2009a).

This presentation will offer results from mapping the volcanic rocks of the Hidden formation, just west of the Mandy Road faults, and the rocks that host the Schist Lake and Mandy deposits, just east of the Mandy Road faults, with a preliminary interpretive reconstruction of the volcanic environment, during formation of the deposits, which will attempt to aid exploration in the area and in similar terranes worldwide.

Theory and/or Method

This study focuses on the strata that host and structurally overlie the Schist Lake and Mandy deposits. Mapping at 1:2000 scale forms the basis of this research and is augmented with petrography, trace and rare earth element analysis and Sm-Nd isotopic data.

Examples

In the Schist Lake–Mandy mines area, the strata both east and west of the Mandy Road faults trends north, dips steeply to the east and youngs to the west. To the north, it is in unconformable contact with the younger sedimentary rocks of the Missi Group. In the study area, rocks of the Hidden formation consist of aphyric to weakly plagioclase-phyric basalt flows, and mafic and heterolithic volcaniclastic rocks. Volcaniclastic rocks are the dominant lithofacies in the southern portion of the study area, but end abruptly along strike to the north (Simard, 2006). An approximately 300 m thick mafic volcaniclastic unit occurs at the eastern shore of Schist Lake, stratigraphically above the ore deposits (Figure 1). This unit is dominated by mafic tuff which occurs on both the east and west side of the East Mandy Road Fault. Aphyric basalt occurs stratigraphically above the mafic tuff unit. This basalt is approximately 60 m thick and is divisible into three separate flows, a lower massive flow, and middle and upper pillowed flows. A heterolithic volcaniclastic unit, consisting of intercalated tuff, lapilli-tuff and lapillistone beds, occurs stratigraphically above the pillowed basalts and is approximately 200 m thick, but thickness estimates are complicated by a gabbroic sill located along its lower contact. A distinctive, 25 m thick unit containing lapilli and blocks rimmed by fine-grained basalt occurs within the volcaniclastic unit. A plagioclase crystal–rich mafic volcaniclastic unit occurs stratigraphically above the heterolithic volcaniclastic rocks and is approximately 300 m in thickness. This is a minimum estimate of thickness, as the unit ends to the west in overburden against an interpreted north-trending strike-slip fault that structurally separates rocks of the Hidden formation from rocks of the Louis formation to the west.

The aphyric basaltic flows west of the Mandy Road faults show the same geochemical characteristics as aphyric basaltic flows within the Hidden formation in the Flin Flon mines area, with low Nb/Y and Zr/TiO_2 ratios as well as small light rare earth element enrichment with a relatively flat heavy rare earth element pattern on the chondrite and mantle normalized trace-element diagrams (Simard and Creaser, 2007; DeWolfe et al. 2009b). However, the ratio of the volume of volcaniclastic rocks to coherent flows in the hanging wall to the Schist Lake and Mandy deposits is significantly more than in the Hidden formation overlying the Flin Flon deposits, where the hanging wall is dominated by basaltic flows.

Conclusions

Detailed mapping indicates that the strata both east and west of the Mandy Road faults trends north, dips steeply to the east and faces west. Tight 'S' and 'Z' folds within the mafic tuff west of the Mandy Road faults may result from drag folding associated with the north-trending faults. However, the continuation of a mafic tuff unit across the East Mandy Road Fault suggests the offset along this fault is not significant. Similarly, there appears to be little offset along the West Mandy Road fault. Thus, the mafic volcanic and volcaniclastic rocks on both the west and east side of the Mandy Road faults are interpreted to be a part of the Hidden formation and consequently the succession forms the hanging wall to the Schist Lake and Mandy VMS deposits.

The hanging wall is dominated by mafic tuff to plagioclase crystal-rich lapilli-tuff to lapillistone. Mafic dikes within the tuff that have peperitic margins are synvolcanic and were emplaced when the tuff was wet and unconsolidated. The thick units of mafic tuff and plagioclase crystal–rich mafic volcaniclastic rocks are interpreted to have been transported by high-concentration mass flows and preferentially deposited in paleotopographic lows or structural basins. The numerous synvolcanic basaltic sills and dikes within the volcaniclastic units suggest that this structural basin was also a mafic vent area and that an extensional regime dominated lower Hidden formation volcanism as in the main Flin Flon VMS camp (DeWolfe et al., 2009a). Since there is no disruption to the stratigraphy across the Mandy Road faults, the limits of the paleograben (defined by the thick, but laterally restricted, volcaniclastic units) when projected stratigraphically downward, could encompass the underlying Schist Lake and Mandy VMS deposits evidence of their longevity and reactivation as magma and hydrothermal fluid pathways.

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