GS-1 Physical description of the Bomber, 1920 and Newcor members of the Hidden formation, Flin Flon, Manitoba (NTS 63K16SW)

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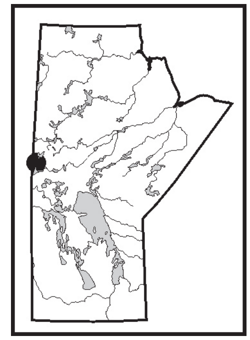

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Summary

The Hidden formation defines the onset of a hanging-wall mafic-volcanic episode to the host strata of the Flin Flon, Callinan and Triple 7 Cu-Zn sulphide orebodies. It comprises, from oldest to youngest, the 1920, Bomber, Newcor and Tower members. The 1920 member, which includes mafic flows with massive, pillowed and peperite facies, is overlain locally by felsic or undivided volcaniclastic rocks of variable composition. The Bomber member, which conformably overlies the 1920 member, occurs as massive, pillowed, breccia and peperite facies, and is itself conformably overlain by the Newcor member. The Newcor member includes massive-, pillowed- and breccia-facies flows, and is locally overlain by mafic volcaniclastic rocks. The Tower member, which conformably overlies the Newcor member, has yet to be examined in detail and is not discussed in this report.

Rapid facies and thickness variations within the 1920, Bomber and Newcor members on the west limb of the F_2 Hidden syncline are interpreted to have been formed in a synvolcanic graben. Of economic consideration with respect to this graben in the Hidden formation is that the faults controlling the location of the graben may have been active over a long period of time, including prior to Hidden formation volcanism, and therefore may have controlled hydrothermal conduits and formation of massive sulphide mineralization in underlying strata. Within the Hidden formation, the volcaniclastic units, which overlie the 1920 member and separate numerous flows within the Newcor member, likely represent hiatuses in volcanism and topographic depressions. They were likely formed in a vent-proximal environment with elevated hydrothermal activity and may therefore be prospective for Cu-Zn sulphide mineralization along strike at depth.

The detailed stratigraphic subdivision and mapping of the Hidden formation strata on the west limb of the Hidden syncline have shown these rocks to have been structurally repeated by low-angle faults interpreted to be thrusts. This has considerable economic significance, as these thrust faults may also structurally repeat the stratigraphically underlying Flin Flon mine horizon.

Introduction

The lateral extent and thickness of the Hidden and Louis formations, as determined from mapping (Stockwell, 1960; Bailes and Syme, 1989; Thomas, 1994; Price, 1997), suggest that they constitute a voluminous basaltic volcano within the hangingwall of the Flin Flon, Callinan and Triple 7 volcanogenic massive sulphide (VMS) deposits (Figures GS-1-1, -2). A premise of this study is that these formations represent an integral part of the volcanic and subsidence history that characterizes the ore-forming environment at Flin Flon. Thus, reconstructing the volcanic architecture and the magmatic, subsidence and hydrothermal history of this basaltic volcano are primary objectives of this research. The identification of synvolcanic structures that control Hidden and Louis formation volcanism may mark hydrothermal conduits to buried VMS deposits, and their identification will not only aid exploration in the Flin Flon camp but also add to our understanding of processes forming VMS deposits during evolution of submarine volcanic complexes.

The objectives of this research are to

- reconstruct the architecture and morphology of the Hidden-Louis volcano through detailed analysis of its different lithofacies and intrusive components, particularly the density and orientation of synvolcanic dikes, sills and cryptoflows;
- compare the evolution and morphology of this ancient volcano to those on the modern sea floor in analogous tectonic environments;
- establish a chemostratigraphy for the Hidden and Louis formations that will aid in stratigraphic correlation between volcanic facies in different structural blocks, and thereby facilitate the reconstruction of this ancient volcano;
- determine the timing of emplacement of the Hidden and Louis formations;
- ascertain the petrogenesis of the basaltic and basaltic andesite flows that constitute the Hidden-Louis volcano, and their volcanic-tectonic setting and relationship to footwall units;
- determine the petrogenesis of the 1920 member or icelandite unit and what significance, if any, the processes responsible for icelandite formation had on the evolution of the Hidden-Louis volcano and

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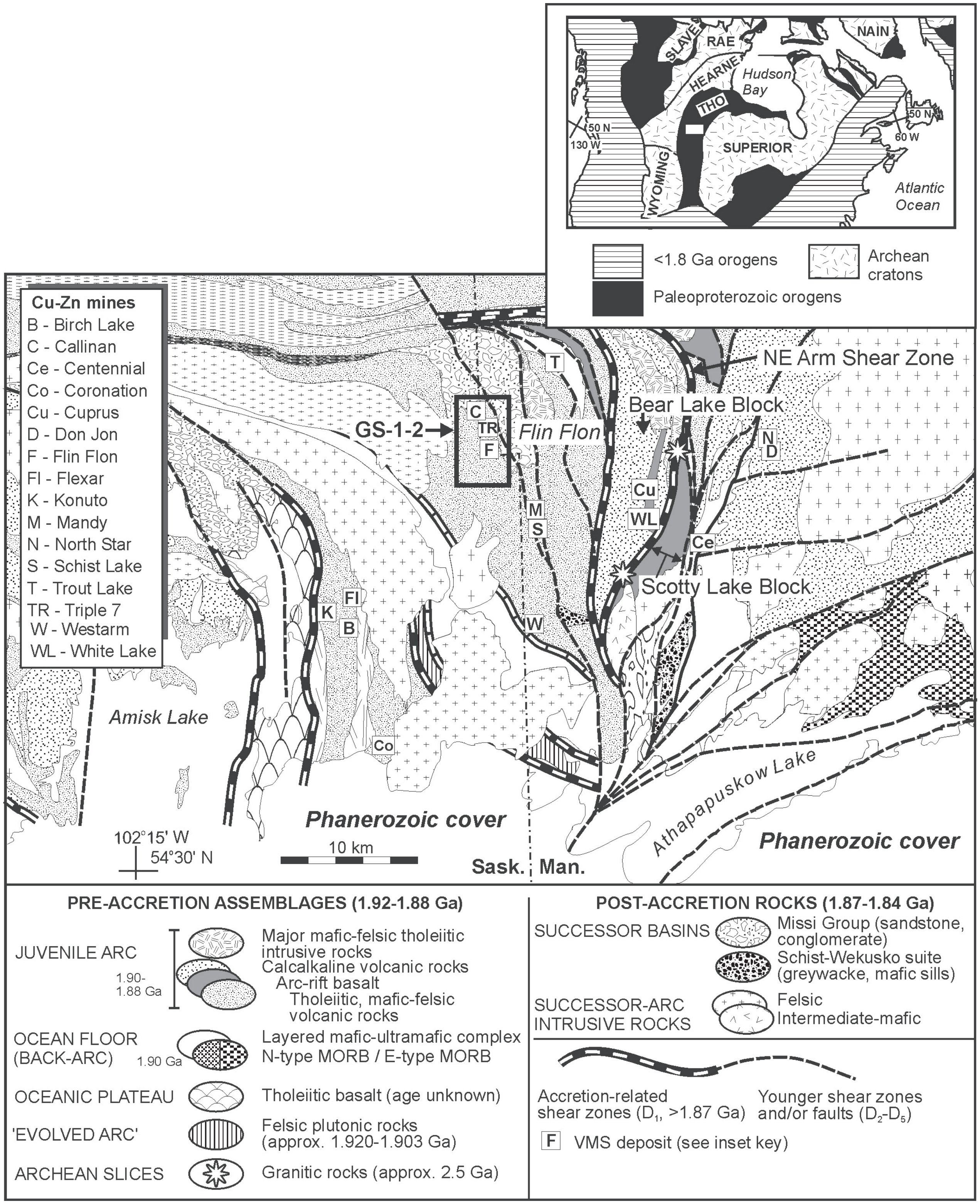

Figure GS-1-1: *Geology of the Flin Flon Belt, showing the locations of known volcanogenic massive sulphide (VMS) deposits (*modified from *Syme et al., 1996). Box indicates area covered by Figure GS-1-2. The inset map shows the location of the Flin Flon Belt within the Trans-Hudson Orogen (THO).*

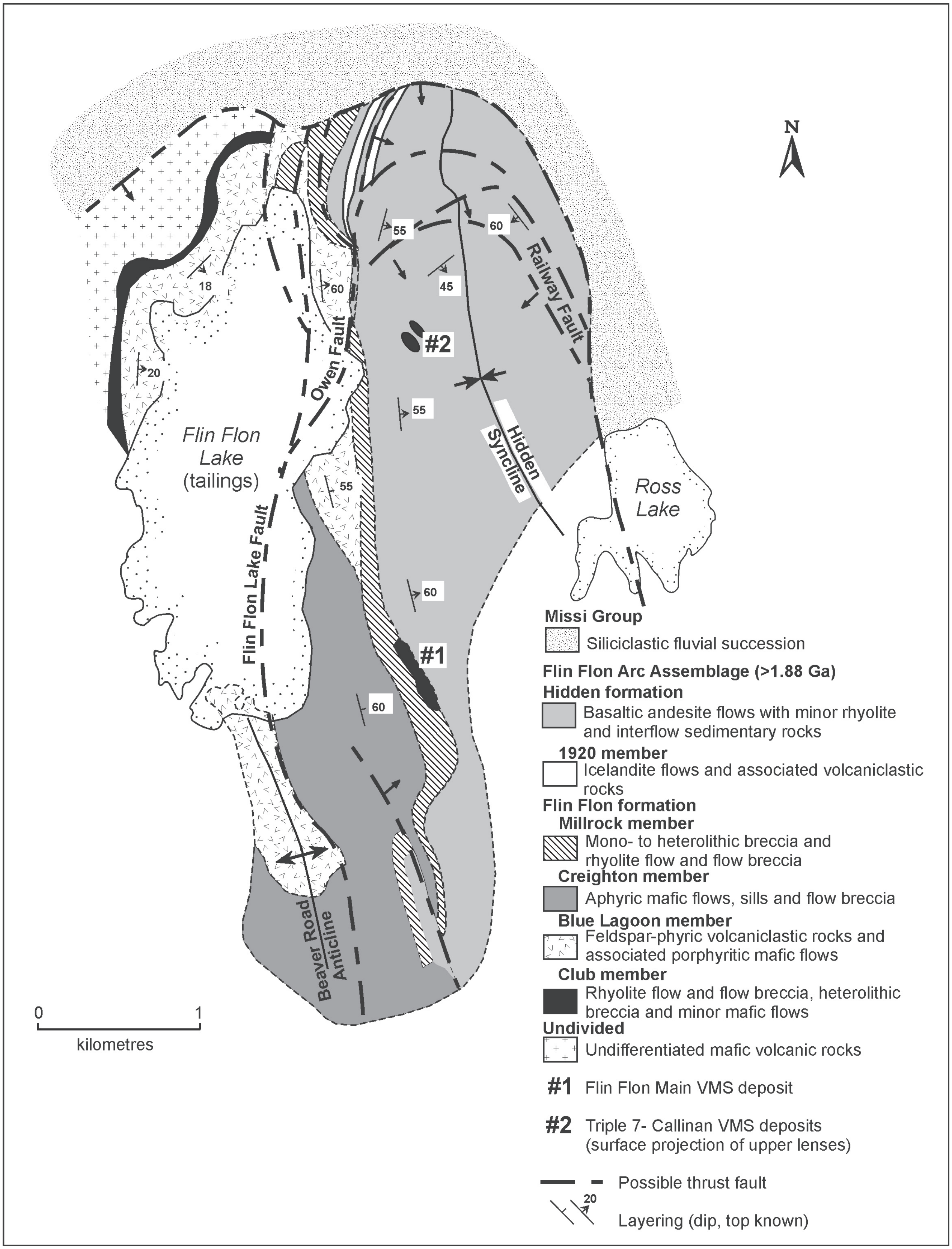

Figure GS-1-2: *Preliminary geology of the Flin Flon area (*modified from *Bailes and Syme, 1989). See Figure GS-1-1 for location.*

formation of its underlying VMS deposits;

- elucidate whether the Hidden-Louis volcano grew during continued caldera subsidence, when subsidence ceased, and the role of fundamental, reactivated structures in subsidence and volcanism; and
- determine the potential of the Hidden-Louis formations to host VMS mineralization.

The purpose of this report is to describe the field characteristics of the Bomber, 1920 and Newcor members, which, along with the Tower member, constitute the Hidden formation.

Methodology

Reconstruction of the magmatic, subsidence and hydrothermal history of the Hidden volcano required that the Hidden formation be mapped on a flow-by-flow basis. Mapping of the Hidden formation was undertaken at scales of 1:1000 and 1:2000, and locally at 1:250 for the purpose of identifing single flows and documenting facies variations and types of alteration. The composition, orientation and density of synvolcanic dikes and sills (>1 m in width) were mapped in order to provide additional evidence of vent proximity and the orientation and location of synvolcanic structures. Representative samples were collected from all flows, sills and dikes for geochemical and petrographic analyses. Selected samples of the 1920 member will be sent for Sm-Nd and Pb-Pb isotopic studies. A sample of the uppermost unit of the Hidden formation, the Tower member rhyolite, will be submitted for U-Pb zircon geochronology in order to provide a minimum age for the Hidden formation. Mapping will provide control and a framework from which to interpret the results of petrographic and geochemical-isotopic studies that collectively will form the basis for reconstructing the volcanic, magmatic, subsidence and hydrothermal history of the basaltic hanging-wall.

In the rock-type descriptions that follow, the terms tuff, lapilli tuff, lapillistone and tuff-breccia are used in a descriptive and nongenetic sense, following the granulometric classification of volcanic rocks proposed by Fisher (1966).

Regional geology

The Paleoproterozoic Flin Flon greenstone belt contains 27 known VMS deposits and is part of the south-eastern Reindeer Zone of the Trans-Hudson Orogen (Figure GS-1-1). The greenstone belt consists of a series of assemblages that range in age from 1.9 to 1.84 Ga (Stern et al., 1995) and include arc, back-arc, ocean-floor and successor-arc successions. The Flin Flon and Snow Lake ocean-arc assemblages contain the majority of the 27 known VMS deposits.

The study area is located in the Flin Flon arc assemblage, which is composed of juvenile metavolcanic rocks (1.91–1.88 Ga) unconformably overlain by fluvial sedimentary rocks of the Missi Group (ca. 1.84 Ga). The rocks of the Flin Flon arc assemblage are interpreted to have been erupted and emplaced in an island-arc–back-arc setting (Syme and Bailes, 1993), and consist of basalt, basaltic andesite flows and breccia, and lesser rhyolite flows. The Flin Flon, Callinan and Triple 7 VMS deposits, which total more than 85.5 million tonnes grading 2.2% Cu, 4.3% Zn, 2.49 g/t Au and 38.16 g/t Ag, are interpreted to have formed during a period of localized rhyolitic volcanism in a synvolcanic subsidence structure, or caldera, within a much larger, dominantly basaltic, central volcanic complex (Bailes and Syme, 1989; Devine et al., 2002; Devine, 2003). The Hidden and Louis formations appear to have been erupted during a period of resurgent basalt volcanism and subsidence that immediately followed a hiatus in volcanism marked by VMS ore deposition.

Stratigraphy of the Hidden formation

The Hidden formation conformably overlies the Flin Flon formation and its contained VMS deposits. The Hidden formation is conformably overlain by the Louis formation. Although the Louis formation will be studied as a part of this project, it is not discussed in this report. The lower mafic flows of the Hidden formation are in contact with thick deposits of plane-bedded, water-laid tuff that constitute the uppermost unit of the Millrock member of the Flin Flon formation (Devine et al., 2002; Devine, 2003). The upper contact of the Hidden formation is defined by the first appearance of strongly (>15%) pyroxene-plagioclase–phyric basalt of the Louis formation.

The Hidden formation consists, from oldest to youngest, of the 1920, Bomber, Newcor and Tower members (Figure GS-1-3a, b). It is dominated by basaltic and andesitic flows, with minor interflow tuff and rhyolite (Ames et al., 2002). Its exposed thickness ranges from 400 to 880 m, but determining this thickness accurately is complicated by D_2 folding and D_1 thrust faulting.

The Hidden and Louis formations contain epidote-quartz alteration, silicification, chloritization, feldspar-quartz alteration and sulphide mineralization. A pervasive middle-greenschist–facies metamorphic mineral assemblage of actinolite-epidote-albite-quartz±biotite was formed during regional metamorphism (Bailes and Syme, 1989).

1920 member

The 1920 member is thought to define the onset of Hidden formation volcanism and is recognized in the field by prominent acicular amphibole phenocrysts. The 1920

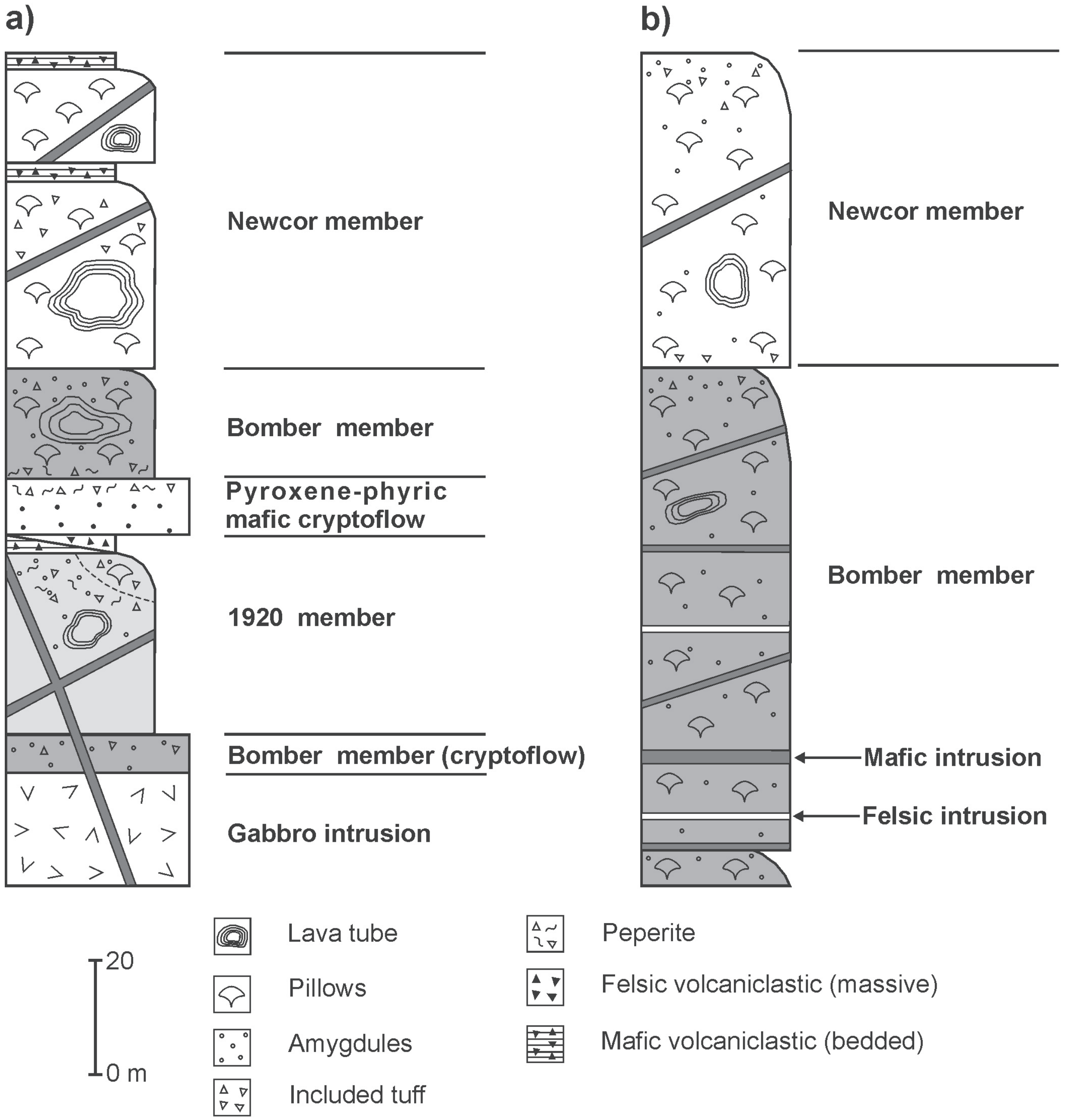

Figure GS-1-3: *Schematic stratigraphic sections of the Hidden formation, showing the stratigraphy on the west (a) and east (b) limbs of the Hidden syncline.*

member is relatively enriched in TiO_2, Fe_2O_3 and P_2O_5 compared with other mafic rocks in the Hidden formation, has an average SiO_2 content of 55.50 wt.% and has been identified as an icelandite by Wyman (1993). For a detailed description of the lithology of the 1920 member, refer to DeWolfe and Gibson (2004).

Distribution

The 1920 member is restricted to the northwest limb of the Hidden syncline and, despite careful mapping, was nowhere identified on the east limb of the syncline. Stratigraphically, the 1920 member occurs at the base of the Hidden formation, where it overlies volcaniclastic rocks of the Millrock member of the Flin Flon formation (Figure GS-1-3a). The top of the 1920 member is marked either by a felsic volcaniclastic unit and by mafic sills of the Bomber member, or by undivided volcaniclastic rocks of variable composition overlain by plagioclase-porphyritic flows of the Newcor member. The 1920 member and these conformably overlying units are recognized in two separate fault blocks separated by two northeast-striking thrust faults that structurally repeat the 1920 member and the bounding basalt sills or flows (DeWolfe and Gibson, 2004).

Bomber member

The Bomber member occurs stratigraphically above the 1920 member on the west limb of the Hidden syncline. On the east limb, where the 1920 member is absent, the Bomber member marks the onset of Hidden formation volcanism.

Distribution

In two fault blocks that structurally repeat the 1920, Bomber and Newcor members on the west limb of the Hidden syncline, the Bomber member occurs stratigraphically above the 1920 member. In the western of the two fault blocks, the 1920 member is in direct contact with the overlying plagioclase-phyric Newcor member, and the Bomber member basalt is observed as a massive, thin (7 m) sill at the base of the 1920 member. In the eastern of the two fault blocks, the 1920 member is overlain by a felsic volcaniclastic unit and Bomber member sills and flows with a maximum thickness of 92 m (approximate true thickness). On the east limb of the Hidden syncline, the Bomber member is in unconformable contact with Missi Group sedimentary rocks and occurs as pillowed flows attaining a maximum thickness of 148 m (approximate true thickness).

Lithology

The Bomber member is a green, aphyric to weakly plagioclase- and pyroxene-phyric (<15%), fine-grained basalt, and occurs as massive, pillowed and peperite facies.

Contact relationships

On the west limb of the Hidden syncline, in the eastern fault block, the Bomber member is in contact with an underlying felsic, pumice-bearing volcaniclastic unit that overlies the 1920 member. The Bomber forms a sharp but irregular contact with the volcaniclastic unit. At its base, the Bomber member is a peperite characterized by a mixture of the underlying volcaniclastic deposits and basalt. The Bomber grades upward from peperite to pillowed facies with included tuff. In the western fault block, and on the east limb of the Hidden syncline, the Bomber member is in contact with the younger Missi Group sedimentary rocks. Locally, the contact is sheared and elsewhere there is 1–2 m of regolith observed at the contact. On both the west and east limbs of the Hidden syncline, the upper contact of the Bomber is conformable with overlying pillowed flows of the Newcor member (Figure GS-1-4). This contact is sharp and commonly marked by large inclusions (6–25 cm) of finely laminated mafic tuff.

Massive facies

Although most commonly pillowed, the Bomber member contains a fine-grained massive facies, which may form up to ~10% by volume of this unit. The massive facies occurs as either sills or massive portions of pillowed flows. Commonly, the massive facies of the Bomber member has sharp contacts with surrounding rocks, indicating an intrusive origin. The massive facies ranges from nonamygdaloidal near the base of the sill to a content of 15% amygdules near the top (Figure GS-1-5a). Amygdules are quartz filled and range from 0.2 to 10 cm in size. Within 1 m of its upper contact, a massive sill of the Bomber member that occurs at the base of and stratigraphically beneath the 1920 member of the Hidden formation contains 5–10% included tuff.

Massive facies of the Bomber member may also occur in sharp contact with surrounding pillowed flows. These massive areas are commonly ovoid in shape and surrounded by, but not truncating, pillows. This suggests that such massive areas are large (>2 m) lava tubes (Figure GS-1-5b). This is further supported by concentric cooling laminations and amygdules concentrated toward their margins; the latter are most prominent toward the stratigraphic top (Figure GS-1-6).

Pillowed facies

The pillowed facies of the Bomber member contains flows that range from aphyric to weakly plagioclase phyric (≤12%) or weakly pyroxene phyric (≤5%). The flows are green (weathered) or dark grey (fresh) and contain amygdaloidal pillows that range in size from 0.5 to 1.5 m in diameter. Amygdules are quartz filled, range in size from 0.1 to 2.0 cm and are commonly concentrated in the core of the pillows rather than toward their top margin. Pillow selvages have an average width of 1 cm and are dark brown to red. Quartz-epidote alteration patches within the Bomber member are readily recognizable as light brown patches in the cores of pillows (Figures GS-1-4, GS-1-5c). Pillowed flows of the Bomber member commonly contain included tuff (Figure GS-1-5d, e).

Breccia facies

The tops of pillowed flows in the Bomber member are seldom brecciated. Where present, the breccia consists of green, fluidal to blocky, aphyric, amygdaloidal basalt fragments in a brown, fine-grained matrix (Figure GS-1-5f).

Peperite facies

Peperite occurs locally within the Bomber member near the tops of pillowed flows. Peperite is a genetic term applied to a rock formed essentially in situ by disintegration of magma intruding and mingling with unconsolidated or poorly consolidated, typically wet sediments or volcaniclastic deposits (Skilling et al., 2002). In the Bomber member, peperite consists of a mixture of

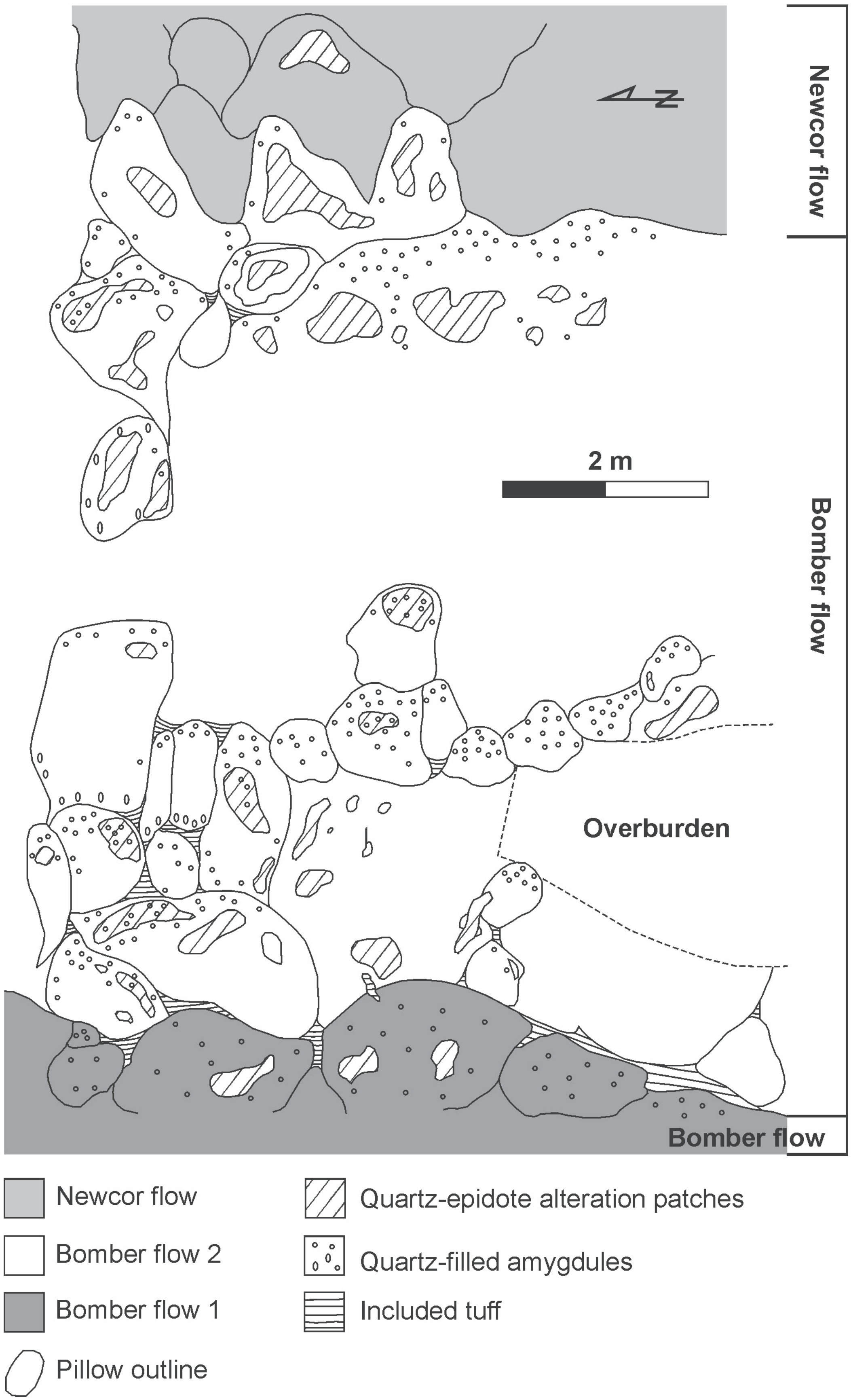

Figure GS-1-4: *Diagram showing the contacts between flows within the Bomber member and between the Bomber member and the Newcor member. Younging direction is toward the top of the page.*

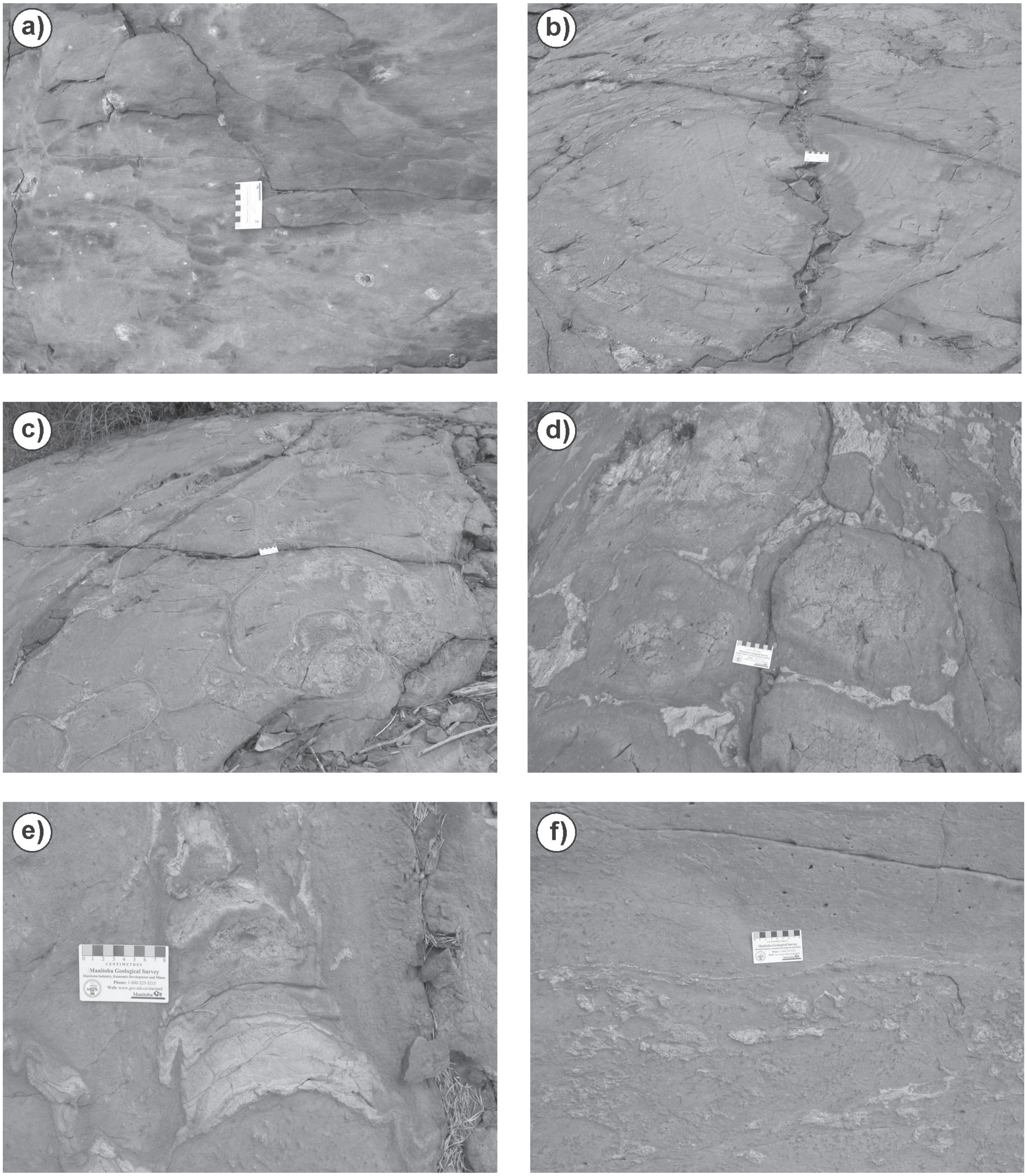

Figure GS-1-5: *Photographs of the Bomber member, Hidden formation, Flin Flon:* ***a)*** *massive, quartz-amygdaloidal basalt;* ***b)*** *lava tube with concentric cooling laminations, centre of photo, surrounded by pillows;* ***c)*** *quartz-amygdaloidal pillowed basalt with patchy epidote-quartz alteration, the pillow morphology indicating younging toward top of photo;* ***d)*** *pillowed basalt with included tuff;* ***e)*** *finely laminated tuff between pillows;* ***f)*** *flow-top breccia in contact with massive base of overlying basaltic flow, facing direction toward top of photo.*

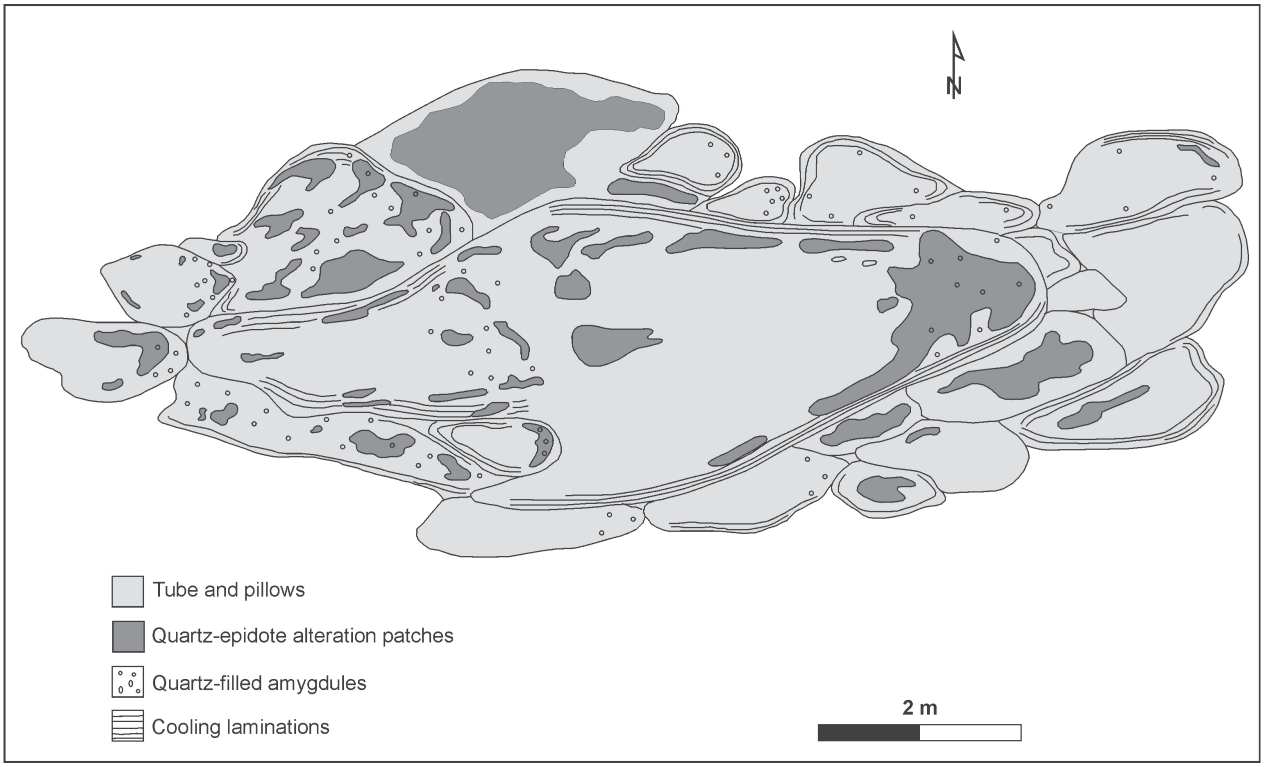

Figure GS-1-6: *Diagram showing basaltic lava tube (centre) surrounded by basaltic pillows; Bomber member, Hidden formation, Flin Flon. Facing direction is to right.*

fluidal to blocky, aphyric, quartz-amygdaloidal (5–40% amygdules less than 1 cm in size), brown basalt fragments (2–30 cm in size) and finely laminated (millimetre scale), epidote-altered, light brown, 2–20 cm mafic tuff fragments. The matrix to the basalt and tuff clasts is a fine-grained brown tuff (Figure GS-1-7a).

Newcor member

Distribution

North of the Railway Fault, the Newcor member occurs on both the west and east limbs of the Hidden syncline, forming a continuous unit around its fold nose (Figure GS-1-2; Price, 1997). The member has a thickness of 57 m on the west limb and 79 m on the east limb (approximate true thickness).

In one location in the western fault block on the west limb of the Hidden syncline, the Newcor member occurs immediately above the 1920 member. It is more commonly located, however, directly above Bomber member flows and sills (Figure GS-1-3a, b). The top of the Newcor is marked by rhyolite and volcaniclastic rocks of the Tower member.

Lithology

The Newcor member is a strongly plagioclase-phyric (≥15%) basalt and occurs as massive, pillowed and in situ–brecciated pillowed facies.

Contact relationships

Where exposed, the strongly plagioclase-phyric pillowed basalt of the Newcor member has an irregular and sharp lower contact with stratigraphically underlying, aphyric to weakly plagioclase- and pyroxene-phyric, pillowed basalt of the Bomber member (Figures GS-1-4, GS-1-7b). This contact is often marked by the presence of finely laminated mafic tuff. Where the Newcor in underlain by the 1920 member, contact relationships are not known, as it is covered by overburden.

Massive facies

The massive facies of the Newcor member is fine to medium grained and contains 15–40% plagioclase phenocrysts (1–4 mm) and 2–8% pyroxene phenocrysts (1–2 mm). The weathered surface of the Newcor is brown and the fresh surface is dark grey. The massive facies is nonamygdaloidal and grades over 10–20 cm into the pillowed facies. The margins of the massive facies with the pillowed facies are locally flow banded and commonly become finer grained closer to the contact (Figure GS-1-7c). The massive facies of the Newcor member locally has 10 m by 10 m areas characterized by columnar joints.

Pillowed facies

Pillows in the Newcor member are plagioclase (15–50%) and pyroxene (≤ 5%) phyric, and fine to medium

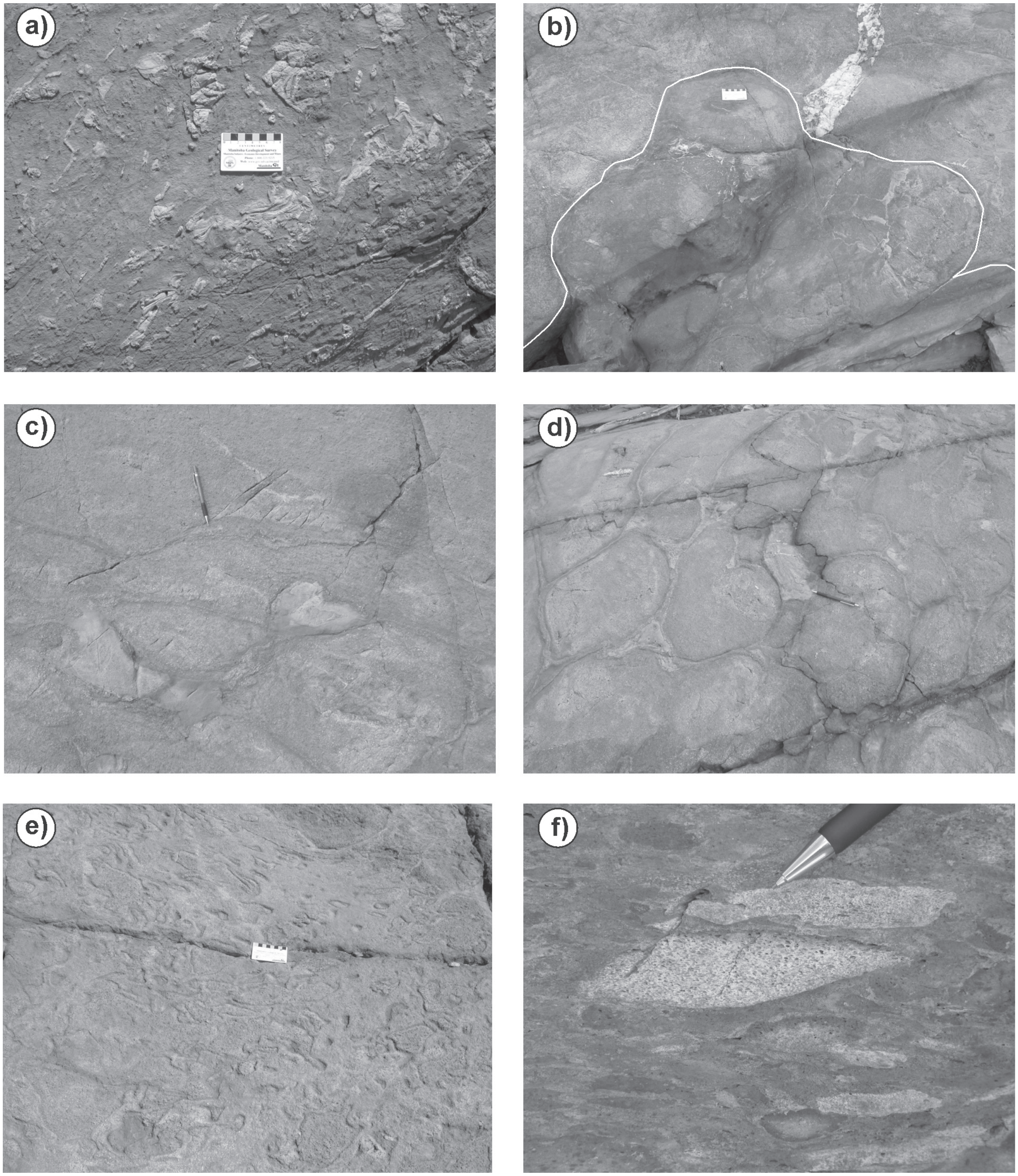

Figure GS-1-7: *Photographs of the Bomber and Newcor members, Hidden formation, Flin Flon:* ***a)*** *peperite (a mixture of basalt and tuff fragments in a tuff matrix), Bomber member;* ***b)*** *contact (white line) between pillowed flow of the Newcor member (top) and pillowed flow of the Bomber member (bottom);* ***c)*** *contact between massive (top) and pillowed (bottom) portions of the Newcor member;* ***d)*** *pillowed basalt with included tuff, Newcor member;* ***e)*** *fluidal flow-top breccia, Newcor member;* ***f)*** *scoriaceous basaltic clasts (light grey) and aphanitic basaltic clasts (dark grey) in a tuff matrix, Newcor member.*

grained. Pillows range in size from 0.2 to 1.0 m and are brown in colour and quartz amygdaloidal, with the amygdules commonly equally dispersed throughout and seldom concentrated toward the margins of the pillows. The pillows have dark reddish brown selvages (1–2 cm wide and locally containing 5–10% euhedral, 1–4 mm plagioclase phenocrysts) and commonly have light brown epidote alteration patches in their cores. Locally, light brown, finely laminated tuff occurs between pillows (Figure GS-1-7d).

An unusual and, as yet, unexplained phenomenon in pillowed flows of the Newcor member is the presence of 10 m by 5 m areas with fractured or in situ–brecciated pillows. These pillows, which contain brown angular fragments (1–10 cm in size) separated by light brown hairline fractures, display a 'jigsaw-puzzle' fit. They are unusual, as the edges of the fractured pillows are still intact. These domains of fractured pillows are surrounded by areas with nonfractured pillows.

Breccia facies

Locally, the pillowed flows of the Newcor member grade upward into fluidal, flow-top breccia units. These breccia units contain quartz amygdaloidal (10–5%, 1–2 mm), plagioclase-phyric (15%) and amoeboid basalt fragments (2–60 cm long) in a fine-grained, dark grey matrix (Figure GS-1-7e).

Volcaniclastic rocks

Within the Newcor member, pillowed basalt flows are often separated by mafic volcaniclastic units ranging from 4 to 20 m in thickness. The volcaniclastic units are clast supported, massive to thinly bedded and composed of 70% amygdaloidal (5–85% quartz-filled amygdules), rounded to subangular basalt clasts (0.2–20 cm with an average clast size of 2 cm) and 10% aphanitic, subrounded to subangular nonamydaloidal basalt clasts (0.2–5 cm) in a light brown tuff matrix (Figure GS-1-7f).

Interpretation

On the west limb of the Hidden syncline, the 1920 member has a thickness of 64 m in the north and thins to 7 m in the south (approximate true thicknesses). This variation in thickness is not due to faulting or folding and has been interpreted to represent a primary, paleotopographic feature, such as a subsidence structure or graben (DeWolfe and Gibson, 2004). The absence of the 1920 member on the east limb of the syncline, as well as the presence of weakly plagioclase-phyric basaltic flows of the Bomber member, which are not present on the west limb, suggests that the 1920 member was restricted to a graben that did not extend to the east limb. Supporting evidence for a graben on the west limb also includes the presence of volcaniclastic units overlying the 1920 member and separating multiple flows within the Newcor member that do not extend to the Newcor member on the east limb. The volcaniclastic units are interpreted to have been localized within a topographic depression.

The 1920 member is interpreted to have been emplaced as a high-level sill or sills into wet, unconsolidated volcaniclastic material on the seafloor, due to the presence of peperite at both its upper and lower contacts (DeWolfe and Gibson, 2004). Where the unit abruptly changes thickness along strike from approximately 64 m in the north to 7 m in the south, it also changes from massive to pillowed facies, suggesting that the 1920 member was locally emplaced on, rather than below, the seafloor; perhaps where the sill had overrun the margins of the graben into which it is interpreted to have been emplaced (DeWolfe and Gibson, 2004).

The local presence of peperite at the top of massive and pillowed basaltic units of the Bomber member suggests their emplacement as massive to pillowed high-level sills or cryptoflows into wet, unconsolidated volcaniclastic material. Peperitic facies within the Bomber occurs mainly on the west limb, again indicating a vent-proximal environment in that area, as opposed to the east limb, where peperite is rarely observed within the basaltic flows of the member. Elsewhere, on both the west and east limbs, pillowed flows of the Bomber member do not contain peperite and are interpreted as having been extruded on the seafloor. The common occurrence of areas (>64 mm) of tuff between pillows suggests the settling of fine, ash-sized tuff from the water column during flow emplacement. On the west limb, large (up to 20 m by 10 m) areas of massive facies surrounded by pillows within flows of the Bomber member are interpreted to be large lava tubes, indicating emplacement in a vent-proximal environment localized within the graben.

The Newcor member is interpreted to have been emplaced as pillowed flows on the seafloor, as indicated by the absence of peperite within the unit. On the west limb of the fold, large areas of massive facies (up to 20 m by 50 m) surrounded by pillows within flows of the Newcor member are interpreted to represent lava channels or tubes. These tubes are located stratigraphically above the tubes of the Bomber member and the thickest portion of the 1920 member, again suggesting a vent-proximal environment localized within the graben.

On the east limb, massive facies, or tubes, within pillowed facies flows of the Newcor member are smaller (<5 m in diameter) and not as common as those on the west limb. Finely laminated tuff between pillows again suggests the settling of fine ash-sized material during the extrusion of Newcor member flows.

On the west limb of the syncline, the emplacement of the 1920 member and overlying Bomber and Newcor members within a vent-proximal environment is indicated not only by the high concentration of lava tubes, but also by the abundance of basaltic dikes and sills within the 1920, Bomber and Newcor members in this area. The dikes often have brecciated or irregular margins with the 1920 and Bomber members, suggesting they are synvolcanic. The abundance of dikes on the west limb coincides with the thickest section of the 1920 member, the highest concentration of lava tubes in both the Bomber and Newcor members, and the occurrence of a large pyroxene-phyric mafic intrusion. They collectively suggest a vent-proximal location within the inferred graben on the west limb of the Hidden syncline. On the east limb of the fold, the Bomber and Newcor flows are thinner and characterized by abundant sills rather than dikes, indicating emplacement farther from a volcanic vent.

Economic considerations

Volcanic facies within the 1920, Bomber and Newcor members, and the abundance of synvolcanic dikes and sills, clearly define the location of a proximal volcanic vent that is localized within a graben on the west limb of the Hidden syncline. The absence of the 1920 member on the east limb and the presence of abundant mafic sills instead of dikes suggest that the graben did not extend to what is now the east limb. Faults responsible for the formation of the graben may have been long lived and active during the emplacement of the underlying Flin Flon formation, where they may have controlled the location of hydrothermal discharge and possibly massive sulphide mineralization. Multiple thrust faults repeat the stratigraphy of the Hidden formation and may also structurally repeat the Flin Flon mine horizon. Patchy, strong, quartz-epidote alteration occurs within the 1920 and Bomber members and, to a lesser extent, within the Newcor member, indicating hydrothermal activity syn- to post-emplacement of the units.

The volcaniclastic rocks that overlie the 1920 member and separate multiple flows of the Newcor member represent hiatuses in volcanism. These volcaniclastic rocks may be prospective units along strike, due to their occurrence within a graben, in a volcanic-vent area and in an area with hydrothermal activity.

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