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REPORT ON A LITHOGEOCHEMICAL COMPILATION AND U-PB GEOCHRON DATING IN REID TOWNSHIP, PORCUPINE MINING DISTRICT, ONTARIO

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15 October, 2016
(Revised and updated 29 December 2016)

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1 SUMMARY

The Reid Township Property is located approximately 30 km northwest of Timmins, Ontario and 13 km west-northwest of the Kidd Creek mine. The property is composed 19 claims and one lease totalling 2,629 hectares.

This report is compilation of 252 newly digitized whole rock analyses from different sources, including 186 samples never before published.

The objective of this compilation is to provide chemostratigraphic information on the geology in east-central Reid Township and to use the whole rock analyses to aid in targeting VMS deposits on the property.

This report summarizes the principal elements of VMS deposits, in a general sense and also specifically those features applicable to the Kidd Creek deposit, and identifies those features that are present on the Reid Township Property.

Three priority target areas have been identified that warrant follow up exploration. Target Area A is located at the top of a felsic volcanic unit composed of FIIIb rhyolites, some of which are VMS-favorable high temperature varieties, with a broad area of alkali element leaching and a zone chlorite index alteration near the top indicating proximity to a vent system and the presence of cross-cutting magnetic structures that could be syn-volcanic feeder fault systems. Target B is located along strike to a well-known VMS mineralized occurrence adjacent to a Fe-Ti basalt-type unit, known to be favorable for VMS mineralization and along a major graphitic formational conductor and FIIIa and FIIIb altered rhyolite. Target C is located further north at the southern contact of a major felsic unit, with FIIIa and FIIIb rhyolites, some of which are high temperature and along which is a major trend of graphitic, formational conductors.

As part of this revised version report analytical results of two geochronological samples are presented which confirm that Blake River Assemblage-aged volcanic rocks are much more abundant than previously suspected and this has opened up some very high potential stratigraphy to host VMS type mineralization within the area of the Reid Property. IEP and its staff through its ongoing research efforts are integrating the significance of this discovery and will use the results to update and improve its targeting for VMS and gold deposits in the district.

2 INTRODUCTION

This report summarizes a continuous and ongoing and mainly private effort by International Explorers and Prospectors Inc. (IEP) and its preceding companies since 1992 to sample and compile bedrock in the Reid Township and presents results for 252 whole rock analyses, 66 of which were previous published in assessment files but not available in digital format and 186 samples never before published. Results are presented in a table at the end and in various maps in appendix.

Table 1: Sample statistics for whole rock analyses included in this report

Samples published in assessment files	66
Samples not published	186
Total	**252**

3 DESCRIPTION OF PROPERTY AND ACCESS

The Reid Property is located in the township of Reid, approximately 30 km northwest of the town of Timmins and 13 km northwest of the Kidd Mine, in the Porcupine Mining District of Ontario (Figure 1).

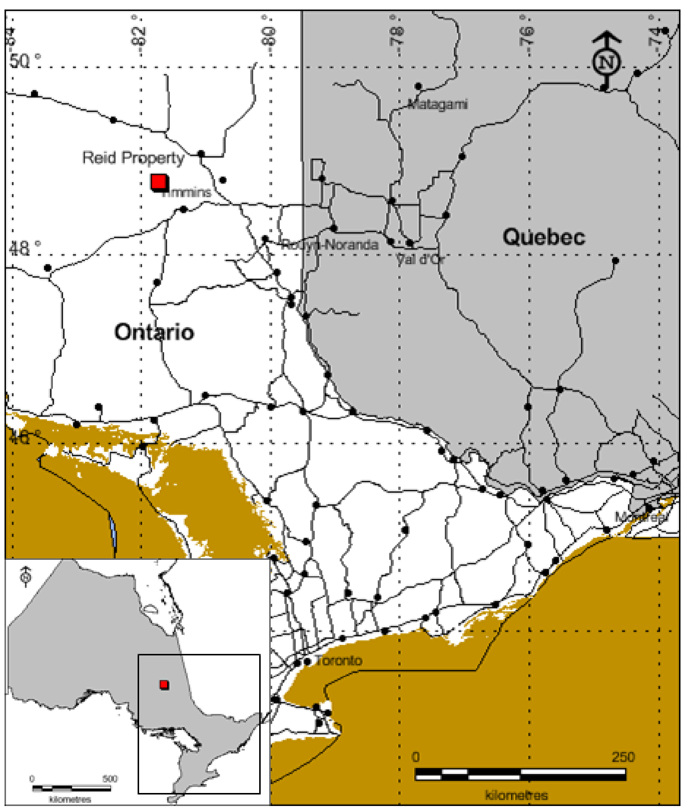


Figure 1: General location map of Reid Township Property.

The Reid property is composed of 19 claims and one lease totalling 2,629 hectares as shown in figure 2 and listed in Table 2.

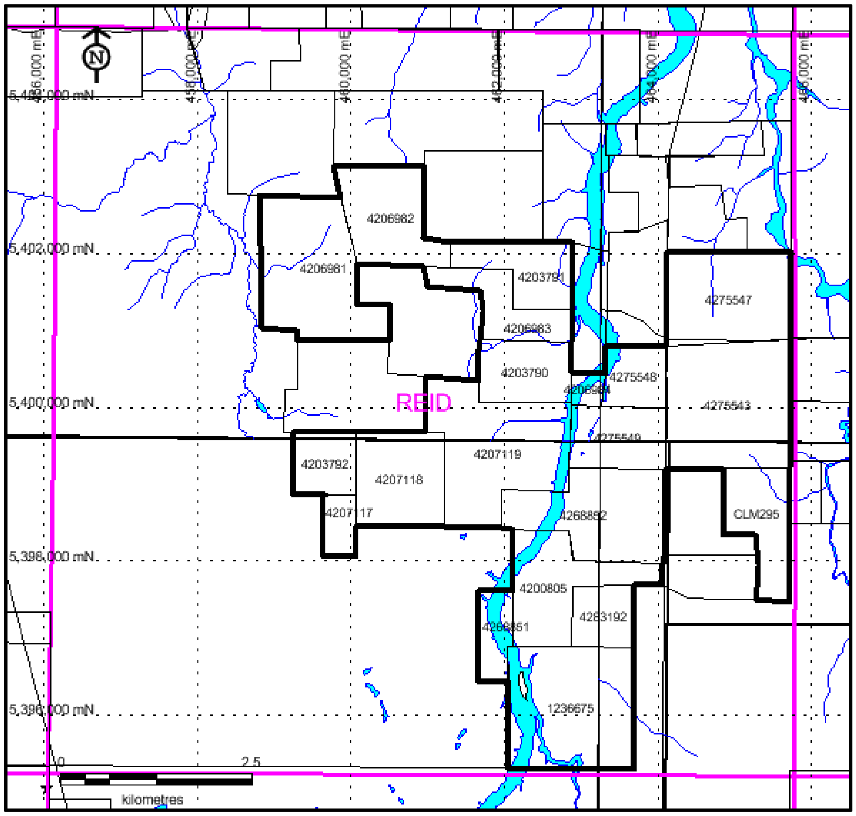


Figure 2: Reid Property Claim and Lease Numbers.

Table 2: List of claims and lease of Reid Township Property.

	CLAIM or LEASE NUMBER	DATE STAKED or ISSUED	AREA (hectares)
Claims	4207118	20050711	140.2
	4207119	20050711	253.2
	1236675	20000322	260.3
	4206982	20050711	142.4
	4268851	20120419	49.4
	4203792	20050527	67.4
	4275543	20140818	264.7
	4203790	20050527	97.1
	4200805	20050311	152.2
	4203791	20050527	95.9
	4206984	20050711	17.8
	4268852	20120710	195.6
	4275548	20140818	64.4
	4283192	20151117	64.5
	4206983	20050711	88.8
	4275547	20140818	191.3
	4275549	20140819	100.5
	4206981	20050711	239.0
	4207117	20050711	34.0
Lease	CLM295	20010101	110.7

The Reid Property is split by the Matagami River. East of the river access to the property is from highway 655 approximately 6km north of the Kidd Mine and from there to the southwest along a forestry road to the east boundary of Reid Township. West of the river, access is from the all-weather forestry road leading north from the Kamkotia mine on the Kami Skotia highway. Approximately 10km north of the mine, a network of forestry roads lead east towards the Reid Property and provides access to much of the land.

4 REGIONAL AND LOCAL GEOLOGY

The West Timmins project area is located in the southwestern part of the Abitibi greenstone Belt (Ayer et al, 2005). The Neoarchean-aged Abitibi terrane forms the southeast margin of the Superior Province of the Canadian Shield (Percival, 2007 and figure 2).

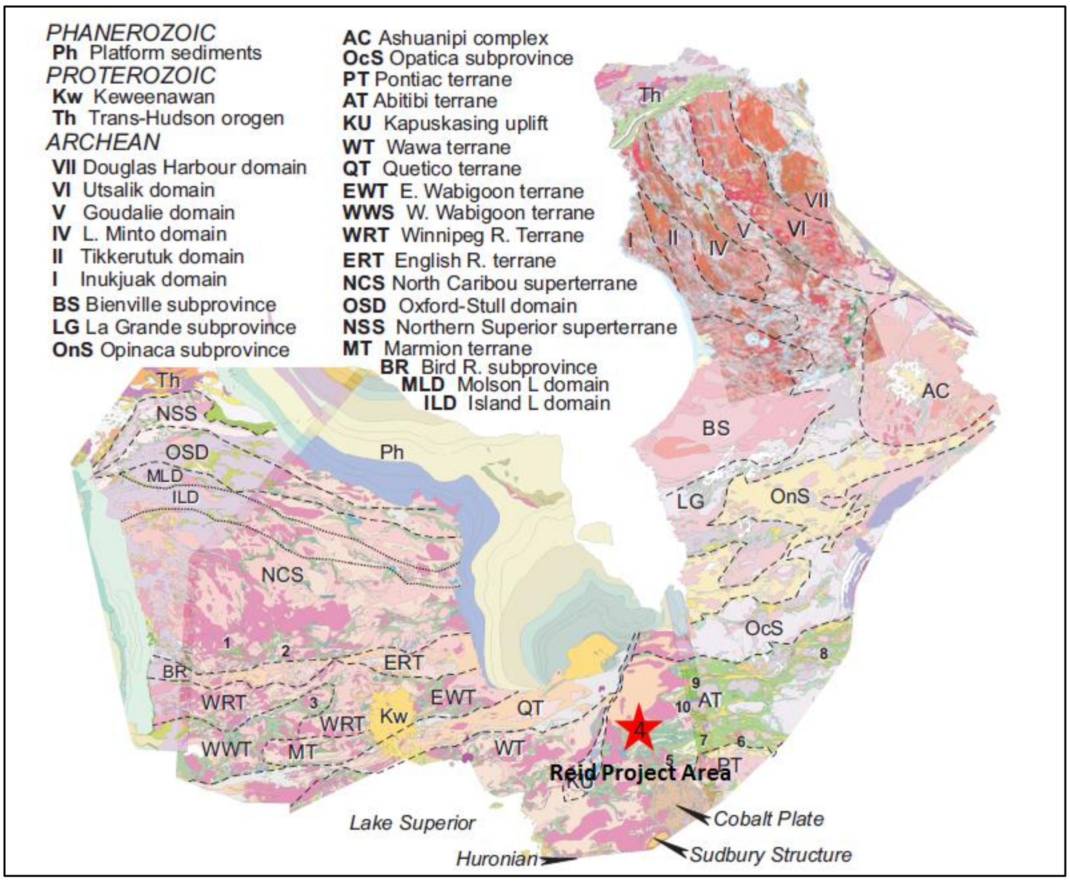


Figure 3: Mosaic map of the Superior Province showing major tectonic elements. From Percival (2007). Major mineral districts: 1: Red Lake; 2: Confederation Lake; 3: Sturgeon Lake; 4: Timmins; 5: Kirkland Lake; 6: Cadillac; 7: Noranda; 8: Chibougamau; 9: Casa Berardi; 10: Normétal. Area of West Timmins Project shown in Blue.

Within the area defined by the Reid Township Project, The Abitibi greenstone belt is composed of a number of assemblages as defined by Ayer et al. (2005) on the basis of regional mapping and by high resolution U-Pb zircon geochronology (Figure 4).

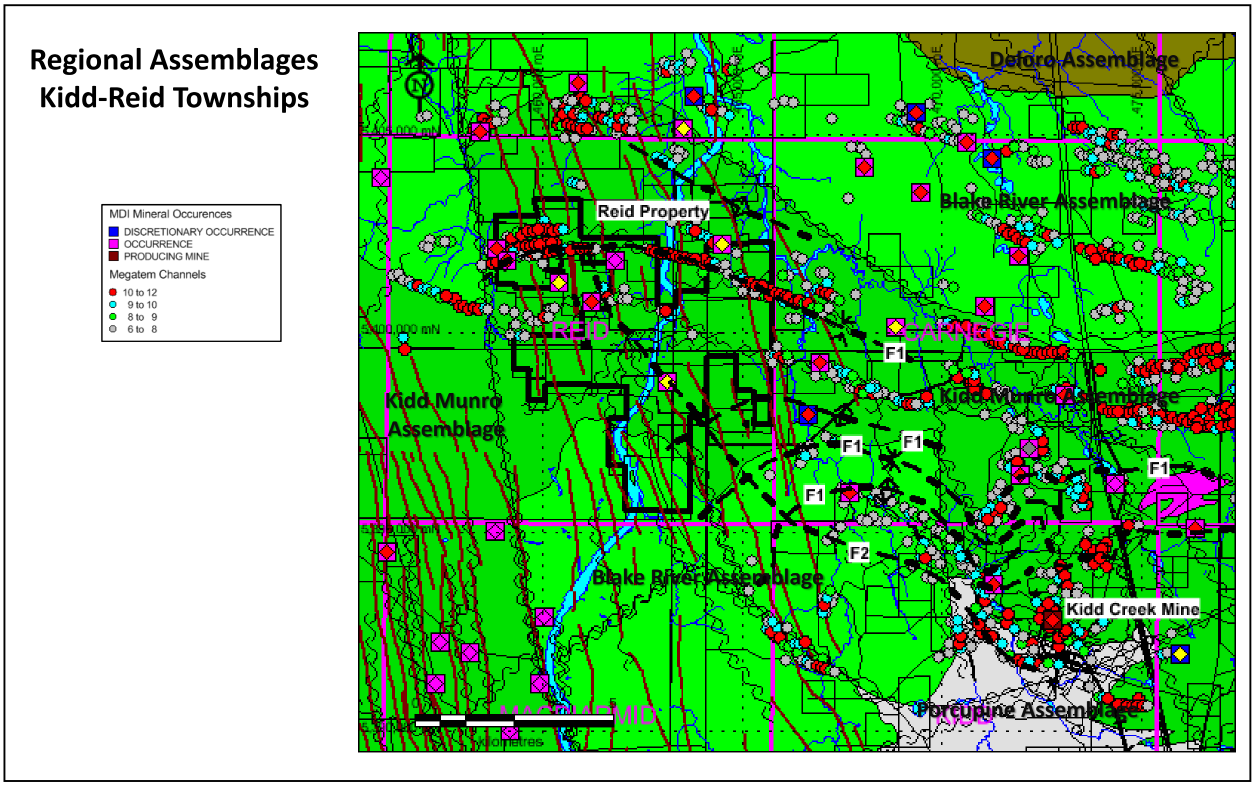


Figure 4: Geological Assemblages in the vicinity of Kidd and Reid Townships. Coordinates in UTM NAD83, Zone 17.

There are very few outcrops in the region between Kidd-Creek Mine and the Reid Property. Almost all out knowledge of the geology comes from historical drilling along with the few outcrops that are present and geological contacts are typically extended and interpolated from airborne geophysical data.

Regionally the Kidd-Munro Assemblage has been extended from Kidd Creek Mine to the western edge of the Reid Property where it is offset and displaced by the Matagami River fault. The geology of the Kidd-Munro Assemblage consists of alternating mafic and felsic volcanic sequences with occasional regional-scale, conductive graphitic sedimentary horizons (figure 5). These horizons are commonly the loci of major unit-parallel faulting that result in facing reversals.

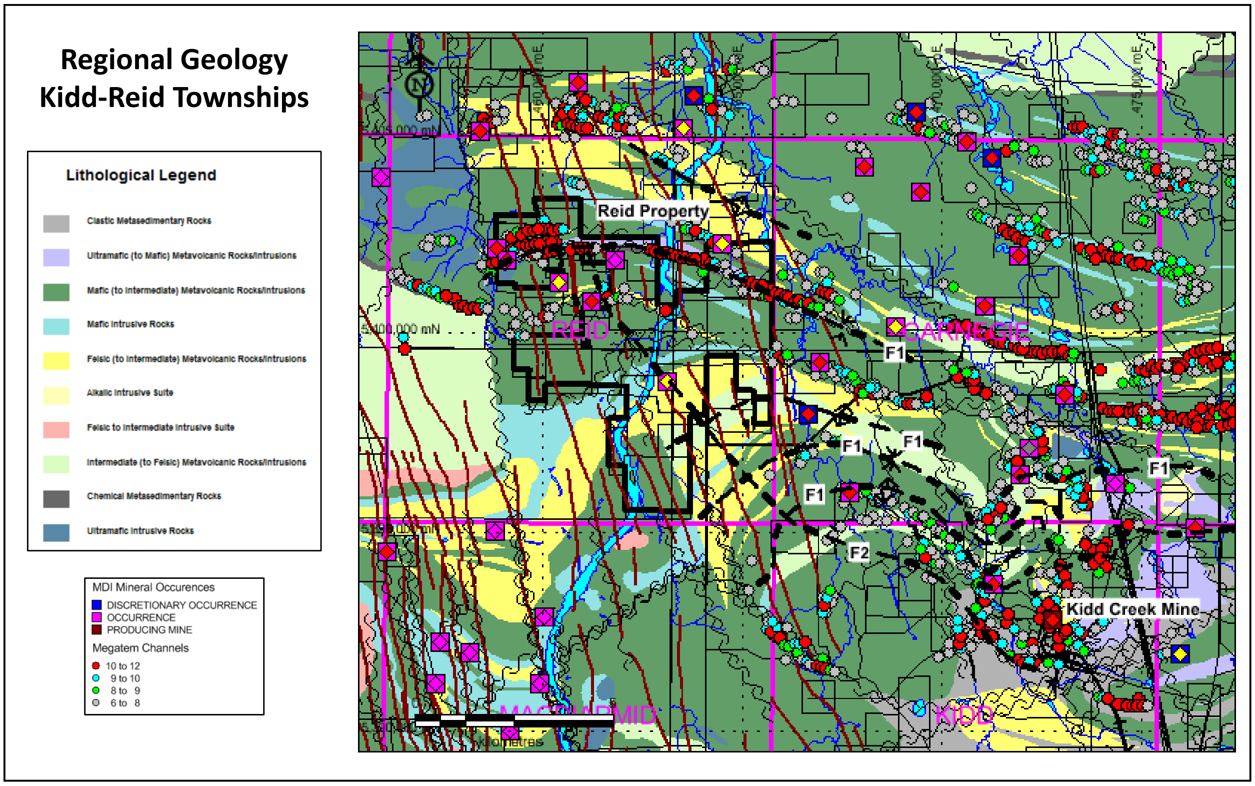


Figure 5: Tectonic Assemblages in the West Timmins Project Area. The Assemblage map from Ayer et al (2005) does not cover the whole area and the western-most edge of the map is represented by the legend shown in figure 1. Coordinates in UTM NAD83, Zone 17.

The oldest unit in the region is defined by the 2730 to 2724 Ma Deloro assemblage composed mainly of calc-alkaline volcanic rocks located along a SE-NW trending belt of rocks in Carscallen township rotating to E-W direction further west in Whitesides township. The unit is capped by a oxide and sulphide-facies iron formation and unconformably overlain by volcanic rocks of Kidd-Munro age (Ayer et al., 2005).

Two belts of Kidd-Munro assemblage rocks occur within the region: in Reid, Thorburn and northeastern part of Loveland townships in the north; and in Carcallen and Bristol townships in the south. The Kidd-Munro assemblage has been divided by Ayer et al. (2005) into a Lower Part with ages ranging from 2719 to 2717 Ma and an Upper between 2717 and 2711 Ma.

Age dating of rocks in the northern belt indicate ages that range across the whole of the Kidd-Munro and includes ages that age equivalent to the period the Kidd Creek deposit was formed. The geology is dominated by tholeiitic mafic and komatiitic rocks with localized felsic tholeiitic units and abundant graphitic sedimentary units. The NNE-SSW trending Matagami River fault has offset the Kidd Munro assemblage by about 8 kilometres in a sinistral direction. The southern contact of the assemblage is defined by the Pipestone fault. In Carscallen township U-Pb dating of felsic volcanics near the lower contact with the Deloro assemblage gave Upper Kidd-Munro ages (2712.2+-0.9Ma; Ayer et al., 2002) suggesting that this belt of rocks was formed in the late stages of the Kidd-Munro assemblage and that major gap of nearly 12 million years may exist between the Deloro assemblage iron formation and the felsic volcanics of the Kidd-Munro assemblage. The top contact of the Kidd-Munro assemblage is located somewhere in Southeastern Turnbull or northeastern Carscallen Township but has never been properly identified.

The Tisdale assemblage (located to the south of figure 5) is divided into a Lower and Upper part spanning the period 2710 to 2706 Ma and 2706 to 2704 Ma, respectively. However in the West Timmins project area only the Lower Tisdale assemblage is present. Detailed mapping by Ferguson et al. (1968) established a stratigraphy defined by komatiites and tholeiites of the Hershey Lake formation overlain by tholeiites of the Central formation followed by variolitic tholeiites of the Vipond formation (2706.9±3.1 Ma: Ayer et al., 2002) and finally capped by tholeiitic volcanics of the Gold Centre formation. The unit is bounded to the south by the Porcupine-Destor fault zone and overlain unconformably by and complexly infolded with Porcupine assemblage rocks. To the northwest the Tisdale assemblage is in contact with older rocks of the Kidd-Munro and Deloro assemblages but contact relations are not well understood.

The Blake River assemblage, which is exposed mainly between the Porcupine-Destor and Cadillac-Larder Lake fault zones near the Ontario-Quebec border, and to the north of the Kidd-Munro Assemblage in the Reid Project area, is divided into Lower and Upper parts with ages of 2704 to 2701 Ma and 2701 to 2696 Ma, respectively (Ayer et al., 2005). The Blake River assemblage is also correlative in age with the volcanic rocks of the Kamiskotia volcanic complex (KVC) rocks in the West Timmins project area in spite of a spatial discontinuity of over 100 kilometres (Ayer et al., 2002). The KVC is composed of mafic and felsic tholeiitic volcanics that occur in a homoclinal sequence that spans the Lower and Upper Blake River assemblage period. Interestingly, no komatiites are present in the KVC. The VMS deposits in the KVC all occur within a narrow interval of time correlative with the Upper Blake River between 2701.1 +-1.4 Ma to 2698.6 +-1.3 Ma (Ayer et al., 2002).

The Porcupine assemblage is 2690 to 2686 Ma in age and contemporaneous with many porphyries and syntectonic intrusions (Ayer et al., 2005). The assemblage consists mainly of distal turbiditic sedimentary rocks composed of wacke, siltstone and mudstone with abundant bouma-sequence subdivisions. Locally the unit may contain calc-alkaline felsic volcanic rocks, conglomerate and iron formation. In the West Timmins project area the Porcupine assemblage only occurs along the south contact of the Tisdale assemblage and in a small inlier in the eastern part of Godfrey Township but more extensively towards the east into Jessop and Mountjoy townships.

5 VMS DEPOSITS: METALLOGENY AND EXPLORATION

VMS deposits are sulfide mineral-rich rock found in intimate relationship with their volcanic host rocks. They are generally composed of massive pyrite and are enriched in zinc, copper, silver and gold. This deposit type forms where hydrothermal convections cells are established in certain volcanic sequences in the top few kilometres of the crust in submarine environments (Figure 6).

In Archean sequences, VMS deposits are typically associated with felsic rocks that have elevated high field strength elements and rare earth elements. Rhyolites are often highly siliceous indicating very high temperature of the melts (Lesher et al., 1986 and Hart et al., 2004). The igneous geochemistry of mafic and felsic rocks associated with VMS deposits can be a useful tool to detect rocks with high fertility potential (Piercey, 2007).

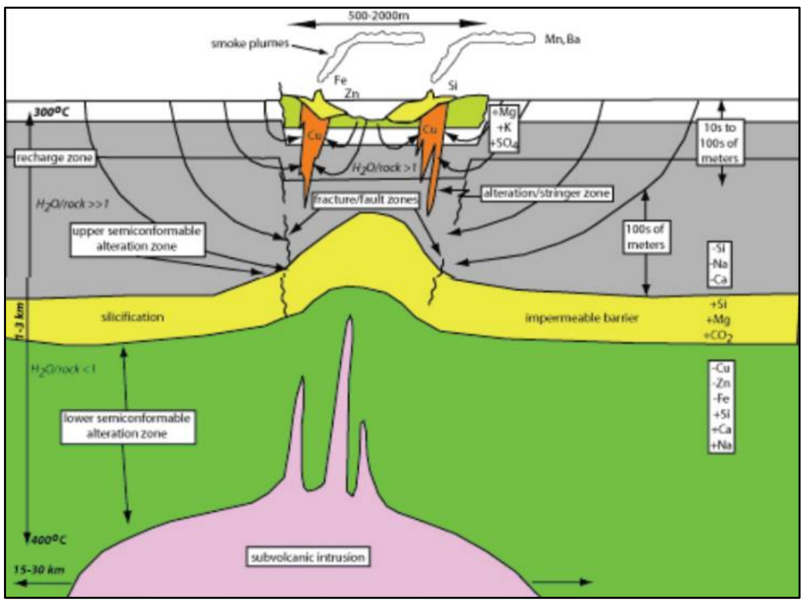


Figure 6: Model for the setting and genesis of volcanogenic massive sulphide (VMS) deposits (from Franklin et al., 2005)

5.1 CONCEPTUAL FRAMEWORK OF VMS DEPOSITS

Because VMS deposits are formed at the same time as their host rocks, the key elements to understand these deposits resides in a detailed understanding of volcanology, their associated high-level intrusions, syn-volcanic structures and hydrothermal alteration. These four elements are necessary to place the prospective deposit within its stratigraphic sequence above a manifestly syn-volcanic intrusion, at the intersection of syn-volcanic faults and fertile horizons and to recognize the alteration effects of ore carrying fluids up the faults, across the stratigraphy and the deposition of their contained metals at favorable exhalative horizons.

In the past exploration for VMS deposits was done mainly with airborne geophysical surveys because many deposits that occur near surface are conductive and may be in part magnetic. In as much as a VMS target in the Abitibi greenstone belt would have these characteristics it has probably been tested and the anomaly explained by some other cause. There is no doubt that the approach was successful, at least in the initial stages of exploration with airborne methods, as witness the discoveries of Matagami, Kidd Creek, Selbaie, and Louvicourt. However beyond these early discoveries the rate of discovery decreased rapidly in spite of a large increase in investment to the point where the last large investment done with this approach by Noranda/Falconbridge in the late 90's early 2000's, lead to only one new mine.

The advantage of the geophysical approach was that an understanding of the deposit was not necessary to discover it, something that is very useful, especially in the Abitibi where much of the terrain is covered by glacial and post-glacial sediments and where knowledge of the local stratigraphy is very limited and sometimes non-existent. The problem however is that beyond those directly detectable deposits (i.e. conductive and magnetic) there is little understanding of the environment in the hole unless an effort is made to use the existing drilling to build the geological map of the territory, in absence of outcrops, in order to reach a level of understanding of the four elements mentioned above. This has not generally been done by exploration companies except in the immediate vicinity of operating mines, but remains a critical approach to exploration in absence of a direct geophysical response of the orebody.

5.2 Exploration Criteria for VMS Deposits

Metallogenic models of mineral deposits are conceptual in nature and as such provide an understanding of how they form and the environment in which we expect to find them. However many of the elements of a metallogenic model do not have observational criteria that can be used to find a deposit. For this the conceptual model needs to be translated into an exploration model that only has elements that are observational in nature. This allows us to relate information to the probability of the presence of a deposit. For an example, and to use the case of airborne geophysical surveys, we know that the presence of an electromagnetic conductor increases the probability of a deposit; so does a punctual magnetic anomaly. But the coincidence of the two increases the odds much more than either feature alone. On the other hand, drill testing of the target with negative results has a strongly negative impact on probability of the presence of a VMS deposit.

Whether one is applying these exploration criteria manually in a regional compilation or automatically using an expert system like those used by government geologists, the result is the same, namely that multiple coincidence of favourable criteria lead to increasing probability of the presence of a sought after deposit. Conversely any testing of the targets with negative results lead to significant decrease in probabilities of discovery. On the other hand a drill hole may have tested, and ruled out, the proximal presence of a deposit but may have provided some significant information that would allow us to infer that we are in the right general environment of a VMS deposit and hence, that the probability of adjacent areas to contain a deposit could actually be increased even if the cell which contains the observation may be discounted. Moreover some criteria, by their nature, are indicative of the environment of a VMS deposit more than the deposit itself and as such increases probabilities over a wide area. These criteria are regional in nature and help to focus exploration in particular areas.

Exploration for VMS deposits entails the identification of favourable volcanic stratigraphy, fertile horizons within that stratigraphy where metal-bearing hydrothermal fluids vented onto the ocean floor, syn-volcanic faults to focus hydrothermal fluids being driven upwards in the stratigraphy in response to convective cooling of sub-volcanic intrusions and the vents themselves where the faults intersect the fertile horizons. Many variants of this scenario are possible depending on the nature of ocean floor during the period when hydrothermal venting occurred, but nevertheless the scenario is almost universal over time and space.

A review of most VMS deposits in the Abitibi greenstone belt shows them to be typically associated with FIIIa or FIIIb rhyolites that occur within a succession of mafic volcanic rocks that overlie syn-volcanic intrusion (Lesher et al., 1986). High iron and titanium-bearing mafic volcanic rocks (Fe-Ti basalts) are frequently present in the immediate hangingwall of VMS deposits. High angle faults with evidence of syn-volcanic movements are often evident if detailed mapping is available. Exhalative, sulphide and chert-bearing horizons are common along strike to known VMS deposits and mark a hiatus in volcanism. Distal alteration that is dominated by and buffered by rock composition is present in the recharge area of the VMS hydrothermal system whereas intense metasomatic alteration is present within the syn-volcanic fault conduits as soon as the hydrothermal fluid starts to interact with sea water. In addition to chlorite and sericite (and their equivalent high metamorphic grade mineralogy) the fluids start precipitating sulphides with or without accompanying base metals.

The challenge in VMS exploration (assuming that direct detection is ruled out) then is to identify those environments which are clearly fertile and conduct exploration in a way that will incrementally lead to progressive approach and then to discovery of a deposit. This can be done most effectively using lithogeochemistry of surface outcrops and drill core combined with mapping where outcrops are present and airborne geophysical surveys to provide some information on geological continuity.

6 LITHOGEOCHEMICAL INTERPRETATION METHODOLOGY

6.1 GENERAL ASPECTS

Modern analytical methods allows one to analyze a large suite of elements with good precision down to the sub ppm level. In particular, modern ICP-ES/MS methods allow us to accurately and routinely analyze the rare earth and high field strength elements in the low concentrations prevailing in mafic and ultramafic volcanic rocks. This has led to tremendous improvements in our understanding of petrochemical processes in volcanic terrains and the possibility of applying lithogeochemistry to chemo-stratigraphic mapping. Moreover these relatively inexpensive analytical methods allow higher density sampling and the interpretation of hydrothermal alteration associated with VMS mineralized systems.

6.2 RELATIONSHIP BETWEEN VOLCANIC COMPOSITION AND VMS MINERALIZATION

Numerous studies in Archean to modern sub-aqueous volcanic terrains have identified specific petrochemical features of volcanic rocks that are correlated with VMS prospectivity. VMS deposits in Archean volcanic terrains are typically found in bi-modal sequences. These rocks are characterized by ultramafic/mafic volcanics on the one hand and dacite/rhyodacite/rhyolites on the other with a compositional gap between 64 and 71 weight percent SiO2 (Gélinas et al., 1977). In the Kidd-Munro Assemblage of the Reid Project the volcanics also show a well developed bi-modal distribution of SiO2 as shown in figure 7.

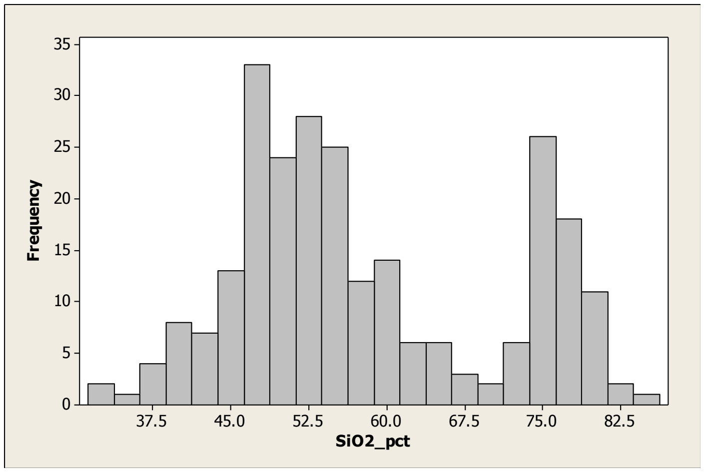


Figure 7: Histogram of SiO2 content of volcanic rocks from Reid Township. Note the bimodal distribution of silica content.

VMS deposits are typically found at or near the top of felsic volcanic units but in detail this is often not exactly the case. Massive sulphide lenses can be found at the top of both felsic and mafic units, the latter often being sufficiently altered and silicified that they resemble much more felsic compositions.

The mafic end members are typically composed of komatiite and basalts of tholeiitic affinity that are the product of high volume melting of lithospheric mantle during arc rifting (Gibson et al., 2007). In the vicinity of the stratigraphic level of VMS deposits the mafic volcanics may show particular and recognizable charactistics resembling icelandite or Fe-Ti-rich basalt and andesite (Perfit et al., 1999; Barrie and Pattison, 1999). These rocks are interpreted by Embley et al., (1988) to be derived from the contamination of basaltic melt by a partial melt generated from hydrated crust, indicating the presence of a high-level crustal magma chamber and possibly the interaction between the mafic magma and the more felsic melts indicated by the presence of rhyolites (Barrie and Pattison, 1999).

The felsic volcanic rocks that are found in VMS districts also have very characteristic compositions. Lesher et al. (1986) and Hart et al. (2004), classified felsic volcanic according to their incompatible element contents with FII and FIII (and lesser FIV) types exclusively associated with districts containing VMS deposits. These felsic volcanics are formed from high silica rhyolite melts formed at high temperatures (800-1,000^{o}C) from partial melting of crust at shallow (<15km) levels within rift environments (Gibson et al., 2007).

Archean VMS districts are generally found in rifting environments that are as varied as they are typical. VMS districts contain characteristic bimodal mafic and felsic volcanics but also sub volcanic intrusions that may predate or postdate mineralization (Franklin et al., 2005). Some of the intrusions are formed of dikes and sills and are very intimately associated with the volcanics and may even show sub-volcanic textures such as peperites and hyaloclastic margins (Finamore et al., 2008; Hathway et al., 2005) whereas other intrusions are quite thick and extensive and represent ponding of large volumes of magma deep within the volcanic succession but close enough to surface to provide the necessary heat to drive the hydrothermal system (Hart et al., 2004). A large portion of these intrusions clearly post-date the VMS mineralization but may be late phases of the same magmatic intrusive-extrusive systems. The compositions and ages of these hypabyssal intrusive rocks are often very similar to the overlying volcanics which has lead many authors to interpret them as comagmatic (Gibson et al., 2007).

6.3 Effects of Hydrothermal Alteration on Volcanic Rock Composition

The volcanic rock sequences associated with VMS districts have invariably undergone hydrothermal alteration. Widespread moderate to strong regional semi-conformable alteration extends for tens of kilometres along strike to major VMS deposits and extends downward from the stratigraphic level of the mineralization to the subvolcanic intrusions. In the upper levels of the system, distal alteration is typical of diagenetic-zeolitic and spilitic conditions whereas deeper down the higher temperatures lead to epidosites composed of epidote and quartz (Franklin et al., 2005).

The semiconformable alteration is the result of infiltration of sea water into the recharge acquifer, becoming progressively heated causing mineralogical changes accompanied by addition of silica and self-sealing of the acquifer, thus isolating it from the ocean floor and allowing the fluids to heat and equilibrate with quartz-epidote and leading to dissolution of base metals (Franklin et al., 2005). The semi-conformable alteration is characterized by low water-rock ratios, no change in rock volume and little or no textural changes in the rock. As a result alteration effects are subtle and difficult to detect using lithogeochemistry (Gibson et al., 2007).

Where the sealed acquifer is disrupted by syn-volcanic faults such as graben bounding structures, the heated, metal-rich fluids can penetrate the seal and move upward towards the ocean floor. This leads to very intense chlorite, Fe-carbonate, sericite, and suphide alteration along the fault as soon as the fluid starts to interact with sea water. Base metal sulphides are precipitated along the fault in a process that leads to pronounced loss of volume. As the fluid approaches the ocean floor interface it mixes with sea water and suffers catastrophic cooling and loss of metal carrying capacity. The deeper, hotter parts of the vent become enriched in copper whereas the shallow portions become zinc-rich in a process of zone refining that is very characteristic of VMS deposits (Gibson et al., 2007). The alteration in footwall volcanics tends to be very intense and characterized by very high water-rock ratios and important loss of volume and obliteration of original textures (Franklin et al., 2005).

If the footwall rocks on the edge of the syn-volcanic fault contain a permeable siliciclastic sedimentary component, the vent fluids may disperse into the unit causing wholesale replacement and producing a much more tabular deposit (Franklin et al., 2005).

Most of the metal deposited in such systems are precipitated beneath the ocean floor within the vent system itself. Any metal that breaches the ocean floor typically gets dispersed and may generate anomalous metal content in cherty Fe-silicate-rich exhalative horizons (see Key Tuffite in Matagami and C and Main contact tuffs in Noranda, Galley et al., 2007).

Alteration of volcanic rocks in VMS districts proceeds from the subtle effects of spilitization in the near surface recharge zone to deep epidositization near the syn-volcanic intrusions to intense chlorite-sericite and sometimes talc in the discharge vent zones. The chemical effects of the former are very subtle but the latter are quite intense. In chemical space the effects of spilitization are recognized at best by moderate leaching of the alkalis Na and K and replacement with Ca. However as alteration progresses more elements become mobile until at the extreme the rock becomes a mono or bi-mineralic mass of chlorite and sericite with some quartz. Mild alteration may be monitored by Ishikawa diagrams but the effects of more intense alteration typically found in discharge zone is better monitored by the Chlorite index, which measures Fe and Mg enrichment, both major elements or, if trace elements are available, using a compatible-incompatible pair of highly immobile elements such as $Al2O3$ vs Zr or $TiO2$ vs Zr.

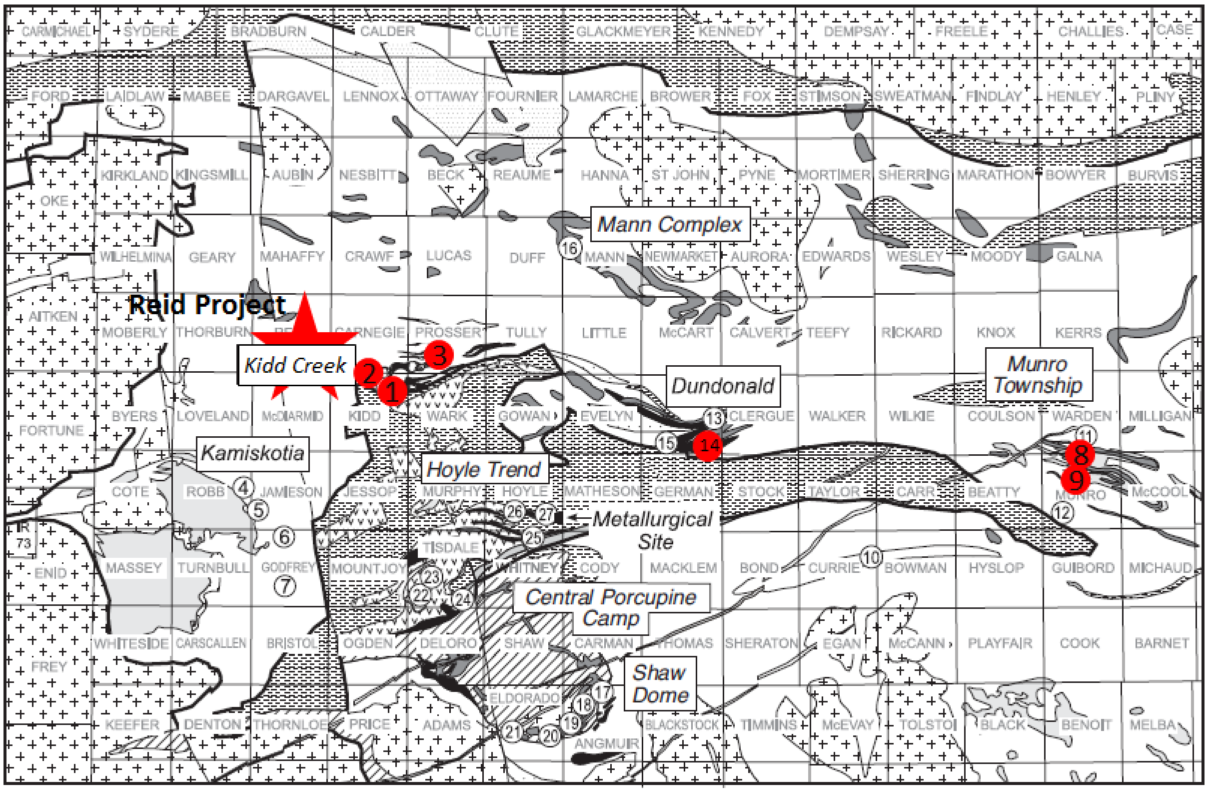
Alteration may extend into the hanging wall and in some cases deposits may be stacked on two or more mineralized stratigraphic horizons. This suggests that there is an interaction between hydrothermal fluid movement and volcanic eruptions and intrusions. When a volcanic flow is erupted over a vent system this tends to isolate the vent system and stop the mineralizing process. However if the hydrothermal system is still active faulting may continue and the vent system may re-establish itself at the top of the newly erupted flow (Gibson and Galley, 2007).

7 VMS DEPOSITS AT KIDD CREEK MINE

The Kidd-Munro Assemblage is host to the world-class Kidd Creek VMS deposit but also a number of other felsic volcanic and komatiite-hosted VMS deposits (figure 8). The most notable are the Chance deposit, located near the Kidd Creek mine, the Potter mine, and the Potterdoal mine.

The Kidd Creek deposit, discovered in 1963 while drill-testing an airborne electromagnetic conductor found near an altered felsic volcanic outcrop, occurs within a bi-modal sequence of komatiite and high-silica rhyolites. However the footwall stratigraphy, which is truncated by the faulted unconformity between the Kidd-Munro and the sedimentary Porcupine Assemblage, is devoid of major intrusions which could have provided a heat source to drive the hydrothermal system that produced the exceptionally large deposit at Kidd Creek (Barrie et al, 1997). The stratigraphic succession in the immediate footwall of the Kidd Creek mine measures at most 1.3 km and is mostly composed of ultramafic flows and sills that reach up to approximately 300 metres stratigraphically below the deposit on surface but approach to within a few tens of metres of the massive sulphides at a depth of 2.5km. The komatiites are overlain by and intermixed with rhyolite breccias in the immediate footwall of the deposit and textural relations and whole-rock chemical compositions suggest the rhyolites were partially melted and assimilated into the komatiites (Barrie, 1999).

Two rhyolite compositions are present in the Kidd Creek deposit. The mine rhyolite, a fragmental, epiclastic, and massive unit that has undergone significant alteration, including silicification, sericitization, chloritization, and carbonatization near the orebodies. The massive facies is typically flowbanded and contains 5 to 10% phenocrysts of quartz and feldspar. The second rhyolite is found in the hanging-wall and is typically a fragmental and epiclastic quartz porphyry rhyolite (Barrie et al, 1997). Alteration is similar to the footwall rhyolite but much less intense. According to Lescher et al (1986) the two rhyolite units at Kidd Creek are strongly tholeiitic or FIIIb rhyolites.



1. Kidd Creek (Cu-Zn)
2. Chance (Cu-Zn)
3. Rusty Hill (Cu-Zn)
4. Kam Kotia (Cu-Zn)
5. Jameland (Cu-Zn)
6. Canadian Jamieson (Cu-Zn)
7. Genex (Cu-Zn)
8. Potterdoal (Cu-Zn)
9. Potter (Cu-Zn)
10. Tillex (Cu-Zn)
11. Hedman (serp.)
12. Munro Mine (asb.)
13. Alexo (Ni)
14. Dundonald (Ni)
    Terminus (Cu-Zn)
15. Frederick House Lk. (Ni)
16. Mann Showing (PGE)
17. Langmuir No. 2 (Ni)
18. Langmuir No. 1 (Ni)
19. McWatters (Ni)
20. Hart (Ni)
21. Redstone (Ni)
22. Hollinger (Au)
23. McIntyre (Au, Cu)
24. Dome (Au)
25. Pamour (Au)
26. Owl Creek (Au)
27. Hoyle Pond (Au)

Figure 8: Locations of selected mineral deposits of the Kidd-Munro assemblage and Timmins region (from Hannington et al., 1999). VMS-type deposits and occurrences highlighted in red.

The hanging wall contains sub-volcanic gabbro sills and dikes and co-magmatic massive, pillowed and hyaloclastic basalts of similar composition. Further up section these basalt-gabbro units are succeeded by massive to pillowed and hyaloclastic basalt flows. These two units differ mainly in that the upper basalts have lower titanium and higher magnesium than the lower unit.

A particular low Ti basalt occurs outside the structural graben or depression that hosts the Kidd Creek mine succession and along the southern and eastern limit of the Kidd 66 basin at approximately the same stratigraphic position as the orebodies (Barrie et al, 1997). These rocks have very low incompatible element contents (TiO2 = 0.32%), high compatible elements (Ni = 380ppm) and can contain up to 11% MgO and are thought to be formed from the remelting of refractory mantle in response to super-heating (Hickey and Frey, 1982). This composition may represent a chemical tracer of a major change in heat flux within the footwall complex that triggers the hydrothermal circulation leading to massive sulphide formation.

Wyman et al. (1999) identified a special Ti-rich tholeiitic basalt unit they call an Icelandite in the immediate hanging wall of the orebodies. This unit occurs both as flows overlying the footwall-correlative rhyolite horizon and as a diorite intrusion within the mine. The chemistry of this unit is characterized by high P_2O_5 (>0.3%) and high TiO_2 (1.7 to 3.6%), high incompatible element content (Zr = 200-340 ppm) and fairly high SiO_2 (>52%) contents. Although the unit is not very abundant its composition is very peculiar was shown to be also present near the stratigraphic horizon of the Kamkotia deposit in the Kamiskotia volcanic complex (Binney and Barrie, 1991) and, as with the low-Ti basalts described above, may represent a particular manifestation of the sub-volcanic magma chamber that is somehow linked to the hydrothermal system that produced the VMS deposits. Certainly from an empirical perspective the observation is valid and merits signaling.

The Kidd Creek mine consists of the north, central and south orebodies, all of which occur within the package of mine rhyolite epiclastic sequence and associated carbonaceous argillite units. The orebodies plunge steeply to the north-northeast and extend from surface down beyond 3km in depth. At surface the three ore lenses extended about 600m along strike before mining and their thickness ranged from 50 to 150 m in thickness. The carbonaceous argillite units overlie the ore lenses and reached a thickness of 50 m near surface in the pit (Barrie et al, 1997). All three orebodies have massive, zinc-rich tops followed downward into massive and semi-massive, copper-rich portions grading into copper-rich stringer mineralization below in the classic VMS zonation profile. However the south orebody contains a very high-grade bornite zone near its base.

Of particular interest at Kidd Creek are the elemental associations found in the deposits. The zinc-rich ores are enriched in Ag, Pb, and Sn and the copper-rich ores are enriched in Co, Se, Bi, and In. This complex metal association indicate that the hydrothermal system was long-lived with different fluid sources at different stages of mineralization (Hannington et al., 1999).

U-Pb geochronology of zircons have constrained the age of the Kidd Creek deposits to between 2,714.3 +-1.6 Ma (footwall rhyolite) and 2,711.5 +-1.2 Ma (hanging wall QP rhyolite) (Bleeker and Parish, 1996).

8 Application of Lithogeochemistry to VMS Exploration

Lithogeochemistry is a critical component to any serious VMS exploration program because volcanic rock composition can be used at different scales from regional area selection down to the selection and prioritization of drill targets. The methods allows us to establish the chemostratigraphy of a volcanic sequence and to identify the most prospective horizons for detailed exploration.

Lithogeochemistry is a fundamentally important data layer for targeting VMS deposits because so many metallogenetic factors are linked to volcanic rock composition. However other factors can contribute almost as much to the prospectivity of a particular property.

Regional mapping is an important tool, at least where outcrops are fairly abundant because this exposes the geology in two dimensions and allows us to establish structural and timing relations between lithologies, something that is much more difficult when working with drill holes only. Regional and property-scale geological mapping can also provide the detailed sampling also that will allow us to relate the lithogeochemistry to observable cross-cutting relationships that can lead us to interpreting the relative timing of volcanic, intrusive, structural, alteration and mineralizing events.

Historical mineral occurrences, especially of stringer, massive or bedded sulphides with elevated base and precious metal content are by far the most important indicator of VMS-type prospectivity at the property-scale. Mineralized float or glacial boulders are also an important because the material was presumably derived from the glacial erosion of a mineralized zone. However, two problems are specific to glacial drift prospecting: finding the source of the boulders is often difficult; and it is impossible to know how much of the deposit was eroded and how much was left in place.

Geophysical response can be an important indicator of shallow VMS deposits. Historically, in the Abitibi nearly all the deposits found after the Second World War were discovered by drilling electromagnetic conductors. It was established early-on that the best VMS targets consisted of short conductors with coincident or near coincident magnetic bull's-eye anomalies. However, by far the most frequent cause of failed drill tests were also on said coincident mag-EM anomalies. Moreover, when the anomalies lacked a magnetic response the odds were even worse. The reason why such an approach was pursued for so long was because it was easy to manage and allowed a statistical approach to the work that was perceived to increase the odds of discovery. Unfortunately, following the first spate of discoveries with airborne EM surveys in the 1950's, subsequent surveys performed very poorly in spite of tremendous technical developments in survey equipment and processing of results.

Finally, historic diamond drilling is very important indicator (or excluder) of VMS mineralization, particularly in regions of the Abitibi covered by glacial outwash and lacustrine clays. In these environments drill holes provide the only direct samples of bedrock that are available. Unfortunately many older holes have not been preserved and lithological descriptions were often very sketchy and sampling sporadic. Plus, often the assay results were not submitted for assessment. In spite of this when a hole was drilled to test an electromagnetic conductor this usually led to a causative explanation for the conductor. Hence, historical drilling can downgrade the significance of an EM conductor. In such cases however, a certain amount of care and due diligence must be exercised to ensure that the EM conductor was indeed tested by the drill hole. The experienced VMS explorationist is keenly aware that VMS hanginwall may be altered but can just as well be absolutely unaltered so that poorly oriented drill holes that stay in the hanginwall and fail to cross the VMS stratigraphic horizon can be strangely uninformative even when a few metres from the contact and potentially several metres of massive sulphides. Downhole geophysics is evidently necessary in all VMS targeted drillholes.

9 LITHOGEOCHEMICAL COMPILATION

The Reid Project has been the subject of numerous exploration programs since 1964, shortly after the discovery of the Kidd Creek Deposit, and a total of 88 diamonds drill holes were collared totalling 16,434 metres. In addition, approximately 35 RC holes were drilled within the limits of the claim group.

From early in the 1980's lower analytical costs for whole rock analyses combined with the realization that VMS deposits are often accompanied by profound chemical transformation of the host rocks in which they occur, explorationists started to routinely collect samples and carry out whole rock analyses of volcanic rocks to aid in identification and to monitor alteration effects. Starting in the 1990's IEP started to collect samples for high quality whole rock analyses, including trace and rare earth element analyses using newly developed ICP-MS technology that made accurate sub-ppm analyses of trace elements possible. However at this time results were considered highly valuable and many of the analyses were not submitted for assessment in order to maintain a competitive advantage. Many of these analyses presented in this report are from these campaigns and are reported publicly here for the first time. In addition, many whole rock analyses found in assessment files from the property area were never digitized and these were hand entered to complete the datafile that is the object of this assessment report.

Sample locations are shown in Figure 10 and are all individually located with sample number in a high resolution map attached to this report (Map 1 in Appendix 2). Sample descriptions and analytical results are included in the table at the end of the report and as an Excel file that is included with the report.

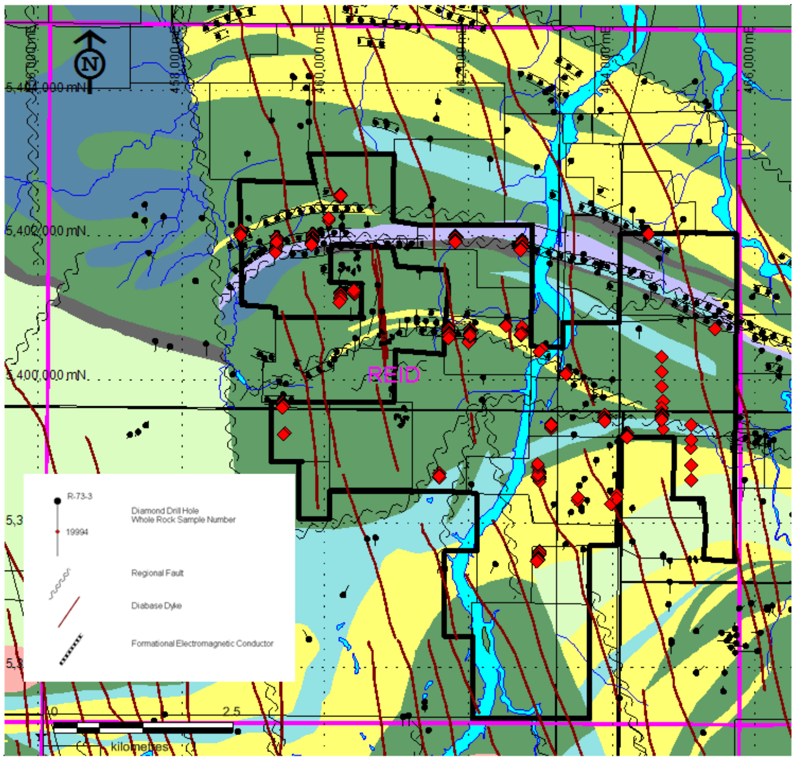


Figure 9: Distribution of 252 whole rock analysis samples from the Reid Township Area. Samples shown as red diamonds. Geology by Ayers et al., 2005. Coordinates in UTM NAD83, Zone 17.

In drill holes wherever possible the samples have been plotted along the surface projection of the drill hole trace. Otherwise if downhole depth was not known or the azimuth and dip of the collar was not known the sample was plotted at the collar.

9.1 Analytical Results and Classification of Samples

Analytical results and interpretation of the sample chemistry are shown in Table A to E in Appendix 1. Table A lists the samples with their locations and classifications from various sources. Table B lists a number of common indices and a few important elemental ratios. Table C lists sample numbers with major elements whereas table D and E list the samples with various trace elements, some of which are only analysed in a few samples.

Results have been plotted in a series of thematic maps printed in A0-size pdf-compatible format as presented in Appendix 2.

Map 1 shows sample locations and sample labels for reference. With the size of area and the large map format and in consideration of the locally high density of sampling along drill hole traces, there is considerable overplotting of labels. In digital pdf format it is possible to zoom-in to any area which will allow the individual labels to be resolved. Sample numbers are plotted along the surface projection of drill holes or at the collar of RC holes or at the sampling location of surface samples.

Map 2 shows the source of the data, whether from Barrett (Barrett and MacLean, 1994a; 1994b), Pyke89 (Pyke, 1989), Falco (Falconbridge DDH database), or AFRI (MNDM assessment file reports). In the last case the AFRI number is also listed for reference. Note that the samples attributed to Pyke89 (6 samples) and to AFRI (31 samples) have been previously published whereas the samples from Barrett (174 samples) and Falco (41 samples) that are listed have not been previously published.

Map 3 shows the chemical classification of samples with, on the right, classified as komatiitic, tholeiitic, transitional or calc-alkaline and on the left, for samples with >63% SiO_2, classified as per FI, FII, and FIIIa or FIIIb (Lescher et al., 1986). This classification is based on the Zr/Y ratio and the abundance of Y in samples. These elements are generally immobile under most conditions and since they are both incompatible their ratio is determined mainly from conditions of partial melting (Lesher et al., 1996; Hart et al., 2004).

Map 4 shows the Zr-content of rhyolites as colour-coded diamonds. Zr in rhyolites is an indicator of temperature with high values indicative of high temperature eruptive conditions, a common feature of rhyolites associated with VMS deposits.

Map 5 shows high Fe_2O_3 and TiO_2 basalts. Although none of the samples have P_2O_5 values greater than 0.3% (a conventional criterium for Fe-Ti basalts) the high TiO_2 values (>1.5%), the anomalously high P_2O_5 (>0.2%) and the stratigraphically restricted occurrence of this particular unit is significant and worth highlighting.

Maps 6 and 7 show the Chlorite and Ishikawa indices, respectively, for the samples in the dataset. The Ishikawa index (Ishikawa et al., 1976), based on the alkali element ratio is very sensitive to hydrothermal alteration but conversely is often misleading in mafic and ultamafic rocks which have very low concentration of alkali elements (i.e. Na, K, Ca). The chlorite index is also misleading in mafic rocks but in felsic volcanics is an excellent indicator of proximity to a vent system.

Map 8 outlines anomalous areas using layers described above and identifies the priority target areas generated from a combination of the anomalous layers.

9.2 VMS Target Generation

From the different thematic layers generated in this study six specific anomaly layers were prepared from the following layers:

- Mineralization
  - Inventoried base metal or gold mineralization within the volcanic succession. These are likely derived from VMS type activity.
- Airborne electromagnetic anomaly picks
  - Moderate to good conductors are typically bedrock sourced and usually caused by graphite or more rarely VMS-type sulphide mineralization.
- Ishikawa alteration index
  - This in alkali leaching index very sensitive to hydrothermal alteration. This is generally the only alteration observable in the recharge zone.
- Chlorite alteration index
  - More intense alteration observable near discharge zones.
- Fe-Ti basalt compositions
  - Fe-Ti basalt composition commonly observed at and above the stratigraphic position of the VMS deposits in Kamiskotia district (Barrie and Pattison, 1999) and along strike to the Kidd Creek orebodies (Wyman et al., 1999).
- Low-Ti basalt compositions
  - Low-Ti basalts are magnesium-rich volcanics with high Cr and low Zr and are found in the hanging wall of the Kidd Creek deposit.
- High-Zr rhyolite compositions
  - VMS mineralized horizons often found where the rhyolites reach a maximum of differentiation recorded by maximum Zr content. High Zr content can also be due to loss of volume due to intense alteration in VMS vent systems (Barrett and MacLean (1991).

9.2.1 Mineral Occurrences

Historic mineral occurrences are shown in figure 10 and are listed in table 3. Three types of occurrences are present in the area. Base and precious metal occurrences (red diamonds in figure 11) are typically associated with graphitic horizons located along major lithological boundaries between mafic and felsic volcanic rocks. Gold occurrences are also found at similar contacts but since these are often tectonized it is uncertain whether the anomalies represent gold-rich VMS environments or orogenic gold systems.

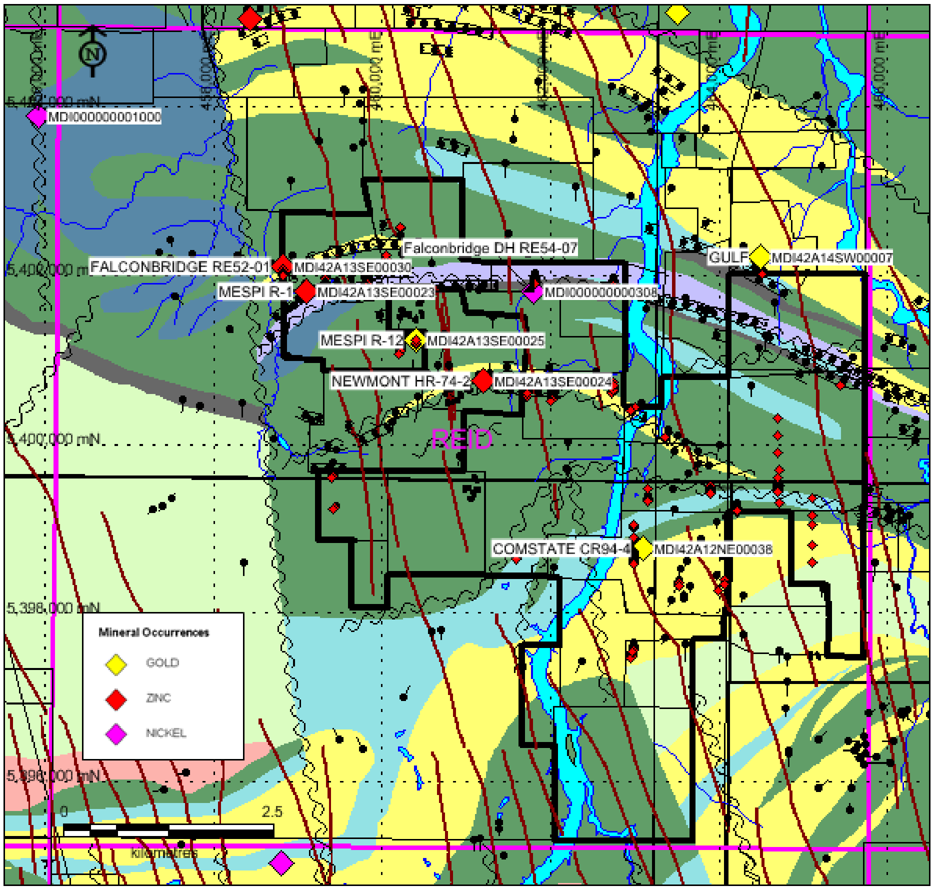


Figure 10: MDI mineral occurrences within and in vicinity of Reid Township Property (From MDI-2013 database).

9.2.2 Geophysics

Total field magnetics and traces of electromagnetic conductors from a Megatem survey are shown in figure 11. The magnetic field highlights ulramafic komatiite horizons and gabbroic sills within the stratigraphy. In addition, numerous north-northwest trending magnetic anomalies map the traces of diabase dikes. The electromagnetic data map the locations of formational graphitic conductors. These are located at major lithological boundaries between mafic and felsic volcanic units and represent carbonaceous sedimentary horizons deposited during periods of volcanic quiescence. Notably, there is abundant carbonaceous sediments within the open pit at Kidd Creek and historical accounts indicate these graphitic units were the origin of the airborne geophysical anomaly that was drill tested at Kidd Creek.

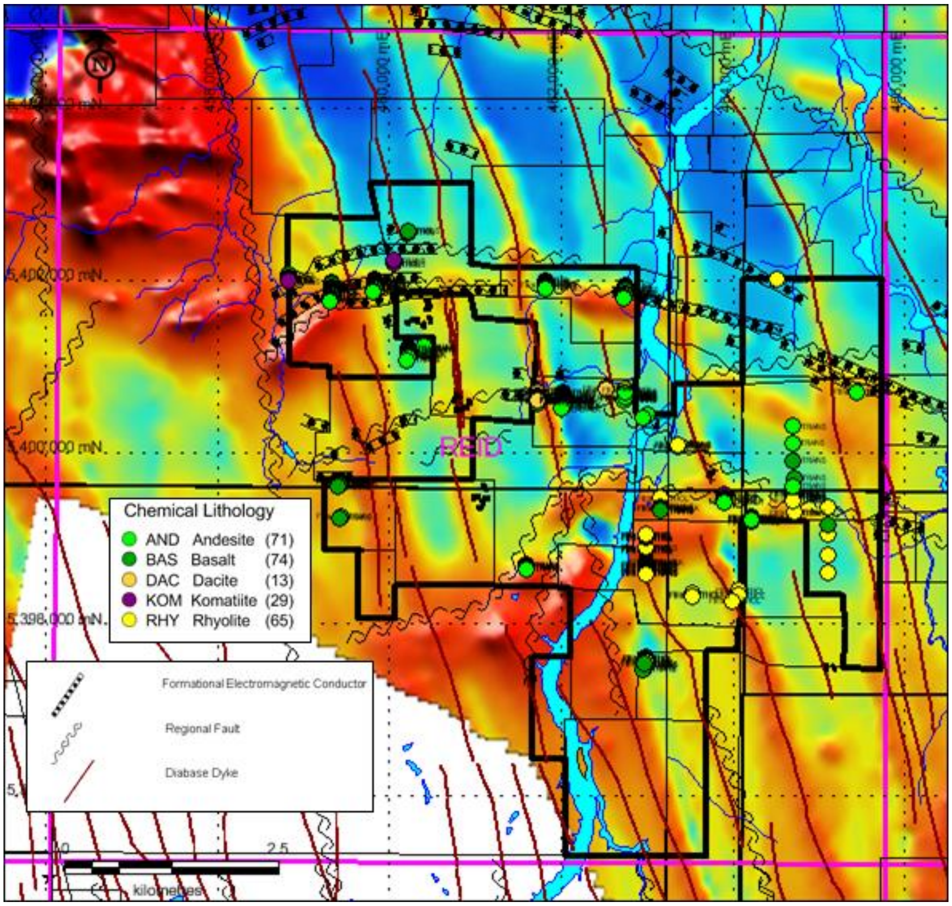


Figure 11: Total Field Magnetics and Chemical Lithology of Whole Rock Samples.

9.2.3 VMS Priority Targets

The different data layers described above can generate an anomaly layer which, in this exercise, was prepared by circling each cluster of anomalies with a coloured polygone and using a different colour for each layer. Then all the coloured polygones were overlain and where multiple coloured polygones occur are where the evidences for a) discharge zones; b) venting of sulphide mineralization; c) stratigraphic positions where both high-Zr rhyolites and Fe-Ti basalts are present; and d) some AEM anomalies nearby are most highly indicative of the presence of VMS mineralization.

Map 8 and figure 12 show the anomalous polygones for each of the anomaly layers along with three priority anomalous target areas for follow up exploration.

Table 3: MDI mineral occurrences within and near Reid Township Property (From MDI-2013 database).

MDI IDENT	DATUM	UTM ZONE	UTM EAST	UTM NORTh	NAME	P COMMOD	S COMMOD	DESCRIPTION
MDI42A14SW00007	NAD83	17	464497.3	5402448.3	GULF	GOLD		Sample P61-87 returned assays of 1320 and 1300 ppb Au from the interval 403.1 ft to 405.1 ft.
MDI42A12NE00038	NAD83	17	463107.1	5399003.2	COMSTATE CR94-4	GOLD		Seven samples of drill core from CR94-4 returned gold assays between 0.60 g/t and 0.17 g/t.
MDI42A13SE00023	NAD83	17	459107.2	5402053.2	MESPI R-1	ZINC, COPPER	SILVER	The graphitic interval from 600 ft. to 660 ft. returned the highest assays: the highest copper value, 0.47%, was obtained from 625 ft. to 630 ft. as well as the highest value in nickel, 0.1%. The highest zinc value, 0.70%, was obtained from 615 ft. to 620 ft.
MDI42A13SE00025	NAD83	17	460407.2	5401468.2	MESPI R-12	GOLD, COPPER		The interval from 284.5 to 289.5 ft. (5.0 ft.) returned assays of 0.02 opt Au, 0.16 opt Ag, and 1.03% Cu and the interval from 294.5 to 299.0 ft. (4.5 ft.) returned Tr. Au, 0.06 opt Ag, and 0.24% Cu.
MDI42A13SE00024	NAD83	17	461215.2	5400993.2	NEWMONT HR-74-2	ZINC, COPPER		The interval from 205 ft. to 208 ft. returned assays of 0.27% Cu, 0.04% Pb, 1.76% Zn, 0.16 opt Ag, tr. Au. The interval from 211 ft. to 216.5 ft. returned assays of 0.17% Cu, tr. Pb, 0.88% Zn, 0.22 opt Ag
MDI42A13SE00030	NAD83	17	458837.2	5402348.2	FALCONBRIDGE RE52-01	ZINC		Assay interval 185.3 - 186.5 m (1.20 m) returned 825 ppm Cu, 5150 ppm Zn, 47 ppm Pb, 653 ppm Ni, <0.2 ppb Au and 0.4 ppm Ag.
MDI000000000308	NAD83	17	461808.0	5402039.0	Falconbridge DH RE54-07	NICKEL		The rocks hosting the mineralization are ultramafic volcanic rocks. The rock was altered and now contains talc-chlorite. The rock sees at least three fault zones in the vicinity of the mineralization.

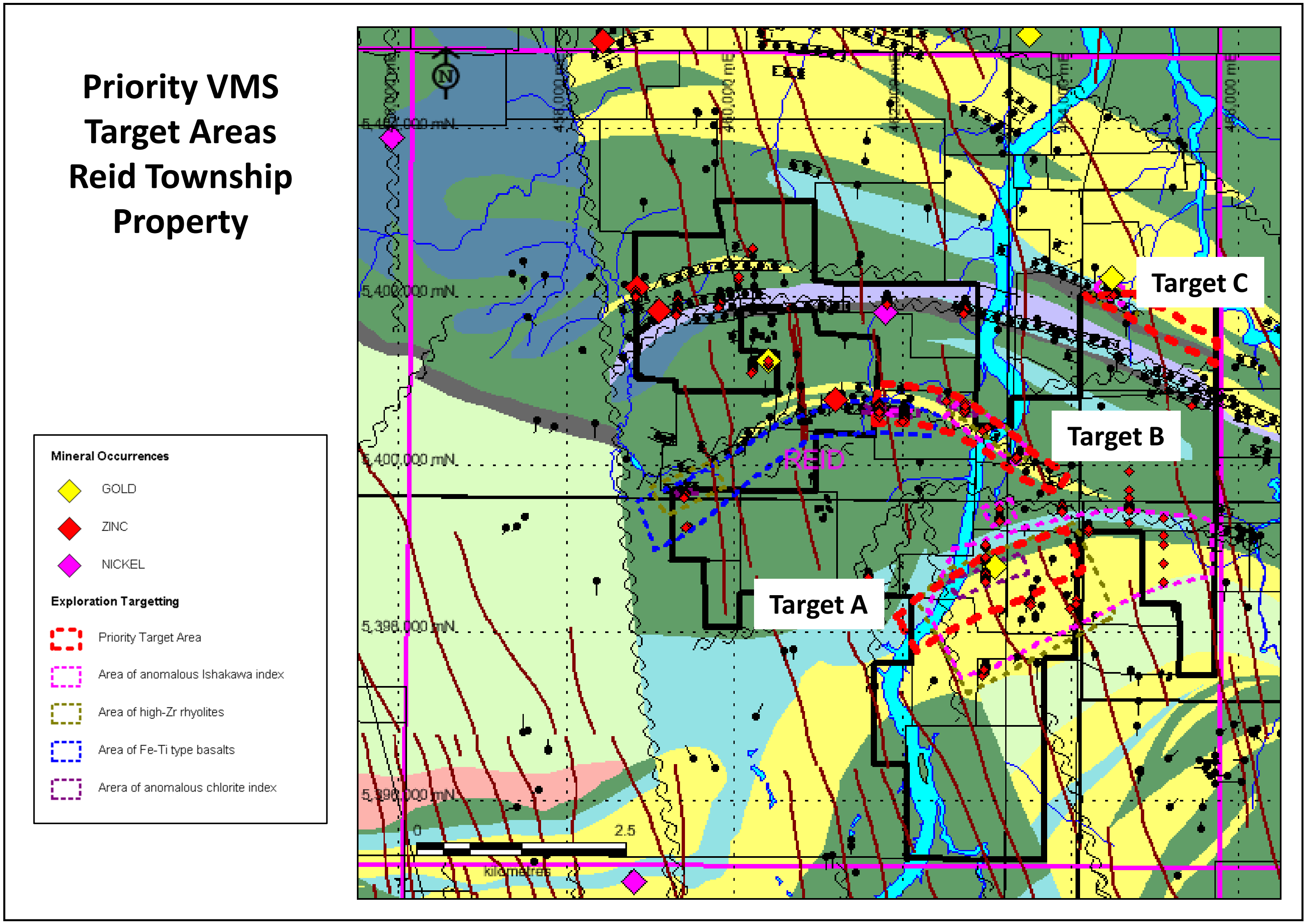


Figure 12: Summary map of VMS anomalies and priority target areas.

Target A in figure 12 is located at the northern contact of Pyke's Southern Rhyolite horizon in the vicinity of intensely chloritized felsic volcanics with anomalous gold intervals. This rhyolitic unit has a FIIIb composition very similar to the footwall rhyolite at Kidd Creek and in particular they contain anomalously high zirconium contents. Although no formational conductors are present, major cross-cutting faults have been mapped and rapid changed in thickness of magnetic units could indicate the presence of syn-volcanic faults. Only 1 diamond drill hole has apparently intersected this contact and much more drilling is warranted.

Target B is located immediately north of Target A and occurs along the same horizon as the Newmont VMS showing. In addition to Ishikawa and Chlorite index anomalies the area is marked by formational graphitic conductors. Several holes drilled to test these conductors intersected relatively thin units of FIIIa and FIIIb rhyolites, some of which have anomalously high zirconium content. To the south of the conductive package is a major mafic unit with elevated TiO_2 and P_2O_5, which resemble Icelandites of Barrie and Pattison (1999). There is evidence of longitudinal faulting associated with the graphitic horizons and the stratigraphic relationships across this unit may not be conformable. Drilling should focus on testing below previous drilling with a focus on structural mapping as well as establishing a chemostratigraphic sequence, which will be important to determine facing directions and any stratigraphic discontinuities that may be present.

Target C is located along the southern contact of Pyke's Central Rhyolite unit, in the northeast corner of the Reid Township Property. This contact is marked a strong formational graphitic conductor and FIIIa and FIIIb high zirconium rhyolites. Moreover anomalous gold values were intersected in drilling. However only 1 hole from this area was sampled so that the extent of the anomalous area is not well defined. More drilling will be required to test this target.

10 U-Pb Geochron Dating

This section is being added to the report as part of ongoing research efforts by IEP and its staff in the continuing development of regional and property-scale geological knowledge and improvements in targetting and metallogenic modelling in the Timmins District.

IEP commissioned some geochronological analyses on samples from the West Timmins area including two samples in Reid Township within the boundaries of IEP's property or on claims on which IEP has some exploration rights under terms of an agreement with Glencore. The report was prepared by Ayer and Hamilton (see Appendix 3) and is submitted here as part of the assessment requirements on the Reid Property. The results of the Geochrons need to be interpreted in the context of the lithogeochemical compilation study which forms the main part of this report.

The study by Ayer and Hamilton confirm that Blake River Assemblage rocks are present in Reid Township, to the south and north of Kidd Munro Assemblage volcanics previously date in the area. Figure 5 in Appendix 3 shows the locations of the two samples analysed in this study (see white squares).

The sample in the southeast corner of Reid Township gave a concordant age of 2,700.8±0.8 Ma, in a felsic tuffaceous rhyolite with quartz and feldspar phenocrysts. This is Lower Blake River in age, the same age as the Horne and Quemont deposits in Noranda and is considered highly favourable for VMS mineralized environments.

The other sample is located in the northeastern part of Reid Township and it is composed of felsic grey-green rhyolite flow breccia and tuff with quartz phenocrysts. The sample returned a concordant age of 2,701.7±1.0 Ma. This is also clearly Lower Blake River and may represent the northern limb of a regional anticline cored by Kidd Munro Assemblage volcanics, the southern limb appearing in the southeast corner of the township.

With this knowledge, IEP has expanded its land holding in the area and its ongoing research will seek to use this new information to reinterpret the airborne geophysical survey to assess the potential of high priority stratigraphic horizons shown in figure 12 to host VMS mineralization.

11 CONCLUSIONS

This study presents some summary targets identified mainly from lithogeochemical data but integrated with a number of other datasets. The Reid Township property shows many of the key features that are typically associated with VMS deposits and, in particular, with the Kidd Creek, deposit located less than 10 kilometres to the southeast. These include high temperature FIIIb rhyolites, Fe-Ti-type basalts, alkali leaching (Ishikawa anomalies) and chlorite metasomatism, graphitic conductors and the presence of base metals and gold in diamond drill holes.

The receipt of results of the geochronological analyses by Ayer and Hamilton (see appendix 3) has confirmed that Blake River Assemblage volcanics are more widespread in the Reid Township than originally suspected. This is extremely important information that complements our lithogeochemical compilation. Research is ongoing by IEP and its staff to integrate fully the implications of this discovery and we are currently reviewing all airborne geophysical surveys in the context of high priority VMS stratigraphic target horizons within the Upper Blake River Assemblage. We are confident this will lead to much higher quality targets than what has been achieved in the past.

The integration of data and updating of interpretations for the area continue and targets are continuously revised for fit to existing models and to new information as they become available.

12 CONTRIBUTIONS

During the period from 23rd September to 15 October, 2016, a number of persons and companies contributed to the assembly of the Reid Township project lithogeochemical dataset and report.

The following are acknowledged:

- Geologist, data entry and report preparation C. Beaudry, P.Geo.
- Ofice Supervision 6070205 Canada Inc.
- 6070205 Canada Inc. Services L. Bonhomme and P. Colbert

30 December, 2016

Charles Beaudry, M.Sc., P.Geo (1202)

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APPENDIX 3

Reid Township and Kamiskotia areas Geochronology, Stratigraphy and VMS Potential

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Mike Hamilton, Ph.D., Jack Satterly Geochronology Laboratory, University of Toronto

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Introduction

Geochronology samples were collected during the summer of 2014 for International Explorers and Prospectors Inc. (IEP) of Timmins, Ontario in the Kamiskotia and Reid Township areas. Identification of the best areas for sample collection was provided by 2 days of consultations by John Ayer, Ben Berger and Greg Stott. Analysis and results on the geochronology samples was provided by Mike Hamilton of the Jack Satterly Geochronological Laboratory (JSL) in 2016.

The Abitibi greenstone belt (AGB) is a difficult area to explore for Volcanogenic Massive Sulfide (VMS) deposits because of the structural complications related to multiple episodes of folding and faulting, metamorphism locally up to amphibolite facies and extensive overburden thickness of glacial till and lacustrine clay. Geophysics, as well as lithogeochemistry, alteration studies and an understanding of the stratigraphic location of favourable horizons for VMS deposition are thus valuable tools in the search for new deposits. In order to better understand the distribution of key base metal bearing stratigraphic assemblages to aid in future exploration for VMS deposits on IEP's claim holdings, geochronological samples were collected in strategic areas based on previous geochronological and lithogeochemical results. In total, 4 new samples of felsic volcanic rock were collected from diamond drill core in Turnbull, Bristol and Reid townships, while an additional rhyolite from SE Reid Township, studied previously (Barrie and Davis, 1990), was reanalyzed using modern methods.

Analytical Methods

U-Pb work was carried out at the Jack Satterly Geochronology Laboratory at the University of Toronto. New rock samples were crushed using a jaw crusher, and ground with a disk mill. Initial separation of heavy minerals was carried out via multiple passes on a Wilfley table to concentrate zircon. Subsequent work included density separation using methylene iodide, followed by magnetic separations with a Frantz isodynamic separator. Final sample selection was achieved by hand picking under a microscope, choosing the highest optical quality euhedral zircon grains (as inclusion-, crack-, alteration-free as possible). Grains with obvious cores were avoided.

Chemical abrasion (CA, Mattinson, 2005) pre-treatment methods were used to improve concordance of zircon analyzed subsequently by isotope dilution – thermal ionization mass spectrometry (ID-TIMS). Selected single grain zircon fractions were annealed in a quartz crucible at 1000°C for a period of 48 hours. Crystals were then leached in hydrofluoric acid (HF) at 200°C in Teflon bombs (Krogh, 1973) for up to 6 hours.

Weights of zircon grains were estimated from photomicrographs and the density of zircon. Mineral grains were washed prior to loading for dissolution. Zircon was dissolved using concentrated HF in Teflon bombs at 200°C (Krogh, 1973), to which a ^{205}Pb-^{235}U spike was added. Samples were dried and subsequently re-dissolved in 3N HCl overnight to promote equilibration with the spike. U and Pb were separated from the solutions using 50 microliter anion exchange columns (Krogh, 1973). Mixed, purified U and Pb solutions were loaded directly onto Re filaments using silica gel and analyzed with a VG354 mass spectrometer in single (Daly) collector, pulse-counting mode. Deadtimes of the measuring system for Pb and U during this period were 15 ns. The mass discrimination correction for the Daly detector was constant at 0.07%/AMU. Daly characteristics were monitored using the SRM982 Pb standard. Thermal mass discrimination corrections were 0.10 ± 0.03% /AMU.

The new zircon chemical abrasion methods, combined with spike refinements and increased instrumental sensitivities, result in more accurate and more precise age determinations than initially possible during earlier studies of the volcanostratigraphy in the AGB. An illustration of this is provided by the re-analysis of the age of an additional sample from SE Reid Township, using leftover zircon separates from the JSL mineral separates archive at the University of Toronto (JAA-14-05; see below).

Blake River Assemblage

The Kamiskotia Volcanic Complex (KVC) consists of an extensive bimodal sequence of tholeiitic basalts and high silica rhyolites located about 20 km northwest of Timmins in the Kamiskotia area of the Abitibi greenstone belt(AGB). The KVC is part of the Blake River assemblage, the youngest volcanic-dominated assemblage within the AGB with ages ranging from 2704 to 2697 Ma (Ayer et al., 2002, 2005). The KVC has a broad northerly strike, extending from a faulted contact with the Kidd Munro assemblage in northern Bristol Township to a second faulted contact with the Kidd Munro assemblage in northern Robb and Jamieson townships (Fig. 1). Extending for over a strike length of 25 km, the KVC represents the second largest accumulation of rhyolites in the AGB, following the ~50 km strike length of felsic volcanics hosting the Matagami VMS camp in Quebec. To the west, the KVC is underlain by the Kamiskotia Gabbroic Complex (KGC), an extensive mafic intrusion with ages ranging from 2707 ± 2 to 2705 ± 2 Ma (Fig. 1). To the east, the KVC is truncated by the Matagami River fault, a north striking Proterozoic-aged fault in which the older Archean rocks of the AGB are sinistrally offset by up to 10 km. A reversal in facing directions indicates a broad northerly trending syncline occurs about 3 km west of the faulted eastern margin (Fig. 1).

Geochronology

U-Pb zircon geochronology by Barrie and Davis (1990) yielded an of age of 2707 ± 2 Ma for a pegmatitic quartz gabbro from the Middle Zone of KGC in southern Turnbull Township and 2705 ± 2 Ma for rhyolite in southwestern Godfrey Township (Fig. 1).

Subsequent higher precision U-Pb zircon geochronology (Hathway et. al., 2008) yielded an age of 2704.8 ± 1.4 Ma from a granophyre sample in the Upper Zone of the KGC in central Robb Township. Their 4 new KVC rhyolite ages ranged from an age of 2703.1 ± 1.2 Ma in the lower part of the KVC in Turnbull Township to 3 rhyolite ages ranging from 2701.1 ± 1.4 to 2698.6 ± 1.3 Ma in the upper stratigraphic part, thus indicating that the KVC is part of the Blake River assemblage (2704–2697 Ma) (Ayer et al., 2005). The upper part of the KVC is more favourable for VMS mineralization containing 5 known VMS deposits extending over 15 km from the Half Moon deposit in Robb Township to the Genex mine in Godfrey Township (Fig. 1).

The IEP geochronological sampling

The program was initiated in 2014 and was focused on extending the extent of known KVC units, the VMS-bearing stratigraphy and to better define the location of the boundaries with the Kidd Munro assemblage. The results of the new dating are discussed below, with U-Pb isotopic data provided in Table 1, and presented graphically Concordia plots with paired zircon population images in Figure 2; new sample locations are shown as white squares in Figure 1.

Sample JAA-14-01 was collected at 97.5 m to 99.0 m from core in DDH ETC-07-5. The DDH is located in southern Turnbull township (UTM Z17; E453556, N5366662). The sample is a felsic lapillistone with heterolithic clasts to 2 cm, with many quartz rich clasts and with minor quartz phenocrysts and moderate but pervasive sericite alteration. Five single zircon fractions from this sample were analyzed. The reported age is based upon the 3 best fractions (Z2, Z4 & Z5 – Fig. 2B). These 3 zircons are all concordant, straddling the concordia band (includes U decay constant uncertainties), yielding a weighted average $^{207}Pb/^{206}Pb$ age of 2703.4 ± 1.3 Ma (MSWD = 0.03; 97% fit). Results for the other two fractions (not shown) are more reversely discordant, one of which gives a $^{207}Pb/^{206}Pb$ age of 2701 Ma, while the other likely reflects minor inheritance, having a $^{207}Pb/^{206}Pb$ age of 2711 Ma (Table 1).

Sample JAA-14-02 was collected from 113.8 m to 115.3 m in DDH ERN-01-01. The DDH is located northwestern Robb Township. The sample is a white to grey rhyolite flow with minor flow breccia with small quartz phenocrysts. No suitable zircons were recovered for analysis from this sample and its location is therefore not displayed on Figure 1.

Sample JAA-14-03 was collected over the depth interval 236.7 m to 238.2 m in DDH EBW-00-01. The DDH is located NW Bristol Township (UTM Z17; E460926, N5366424). The sample is grey to dark grey heterolithic lapilli tuff to tuff breccia with sub-angular to sub-rounded fragments up to 15 cm in a tuffaceous to graphitic matrix with numerous sulfide fragments and secondary sulfide accumulations. Four single zircons were analyzed and yielded two apparent age populations. The youngest population is defined by two fractions (Z2, Z4), and within this, fraction (Z2) is concordant. A free regression of these two points yields an upper intercept age of 2699.3 ± 1.7 Ma, with a lower intercept near 415 Ma (Fig. 2C). The other two single-grain zircon fractions (Z1, Z3) have similar, older $^{207}Pb/^{206}Pb$ ages of 2703.0 and 2705.2 Ma, and regress to give an intercept age of 2706.5 ± 3.7 Ma. The younger age of 2699.3 ± 1.7 Ma is considered the best age of volcanism, while the other two zircons are interpreted as containing an inherited, xenocrystic component.

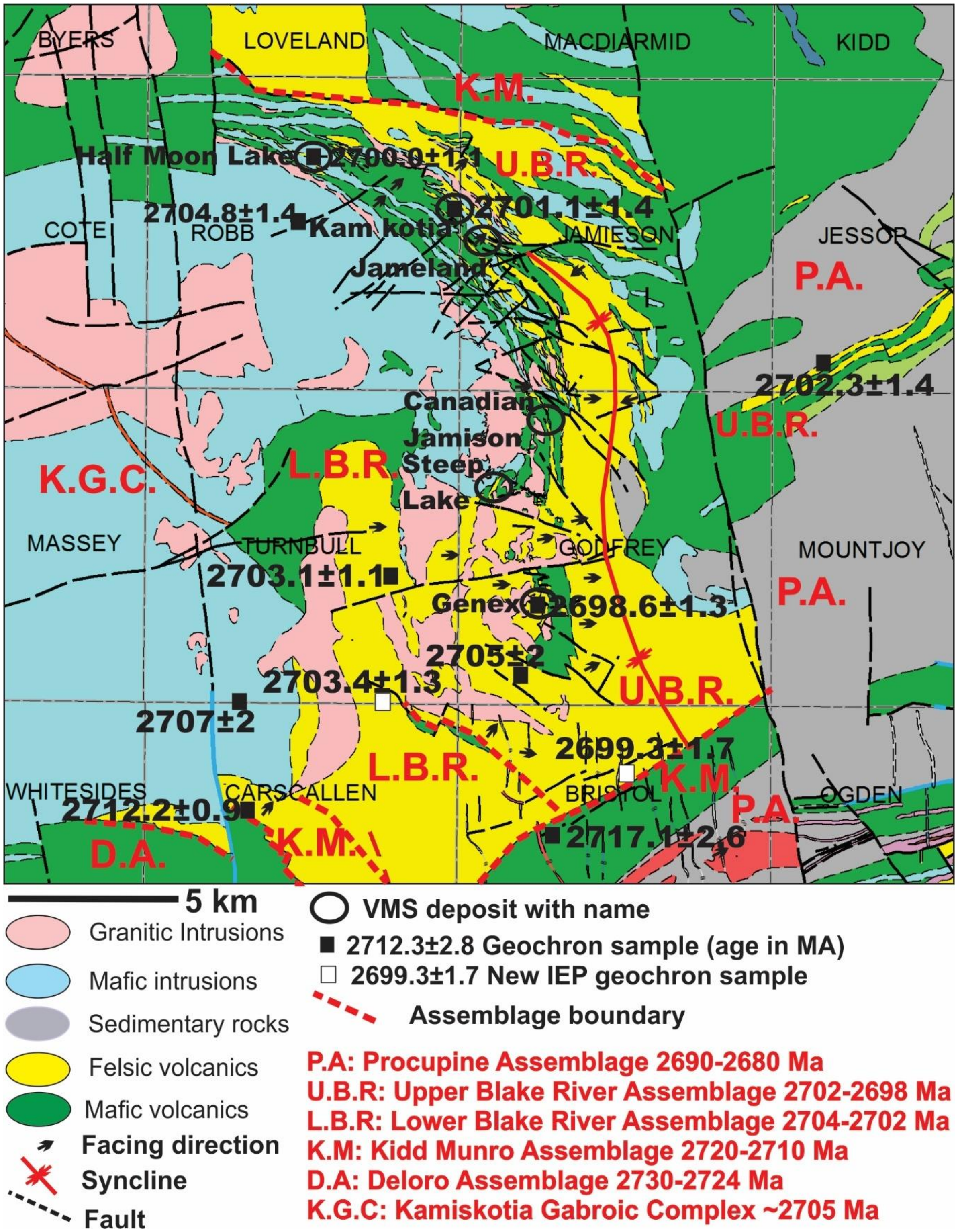

Figure 1. Kamiskotia area general geology with U-Pb zircon ages in MA VMS deposit locations and assemblage boundaries.

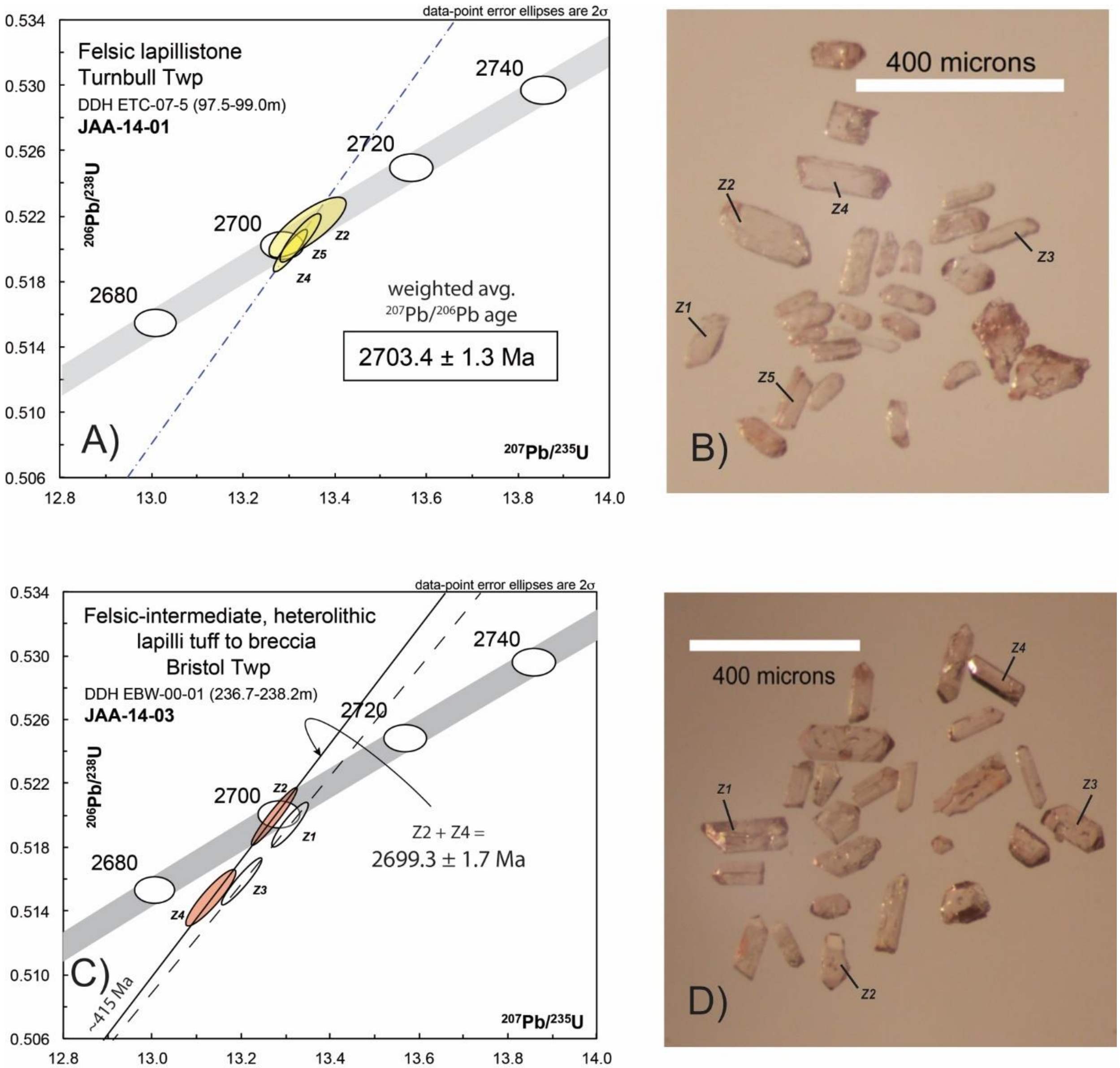

Figure 2. Concordia plots and images of selected zircons from the Kamiskotia area. A & B) Sample JA-14-01, C & D) Sample Ja-14-03.

In addition to being older, rhyolites from the lower stratigraphic part of the KVC have geochemical differences from the upper part as indicated by Hathway et. al., (2008) below:

Rhyolites from the lower part of the Kamiskotia Volcanic Complex, stratigraphically beneath the Genex VMS deposit, have high silica contents (74-82 wt.% SiO^2) and low TiO^2 contents (0.09-0.4 wt. %). REE patterns typically show gentle negative slopes and strong negative Eu anomalies; however, rocks from the lowermost part of the succession (Fig. 3A) have weaker Eu anomalies. In the $[La/Yb]_{CN}$ versus $[Yb]_{CN}$ diagram (Fig. 3C), these rhyolites cluster in the FII field and the low Yb part of the FIIIb field, with most having slightly higher $[La/Yb]_{CN}$ and lower $[Yb]_{CN}$ than the rhyolites of the Kidd-Munro assemblage. In the stratigraphically higher eastern part of the area, but still beneath the Genex deposit, rhyolites

are distinctly enriched in HREE, plotting well into the FIIIb field in the $[La/Yb]_{CN}$ versus $[Yb]_{CN}$ diagram (Fig. 3C). Rhyolites in drill core along strike to the southeast of the Kam Kotia deposit fall in the FIIIb field, and a rhyolite from the felsic lens hosting the Halfmoon Lake deposit falls in the FII field. Rhyolites from the Ski-Hill and Godfrey Creek units in the upper part of the Kamiskotia Volcanic Complex, above the VMS deposits, contain 75 to 82 wt. percent SiO^2 with TiO^2 ranging from 0.15 to 0.4 wt. percent. These rocks show flat REE patterns with strong negative Eu anomalies (Fig. 2B) and plot well into the FIIIb field in the $[La/Yb]_{CN}$ versus $[Yb]_{CN}$ diagram (Fig. 3C). Thus, rhyolites in the lower part of the Kamiskotia Volcanic Complex and at the level of the VMS deposits include FII and low Yb FIIIb types, with minor high Yb FIIIb rocks, whereas rhyolites in the upper part of the Kamiskotia Volcanic Complex are uniformly of the high Yb FIIIb type (Figs. 3C & 3D).

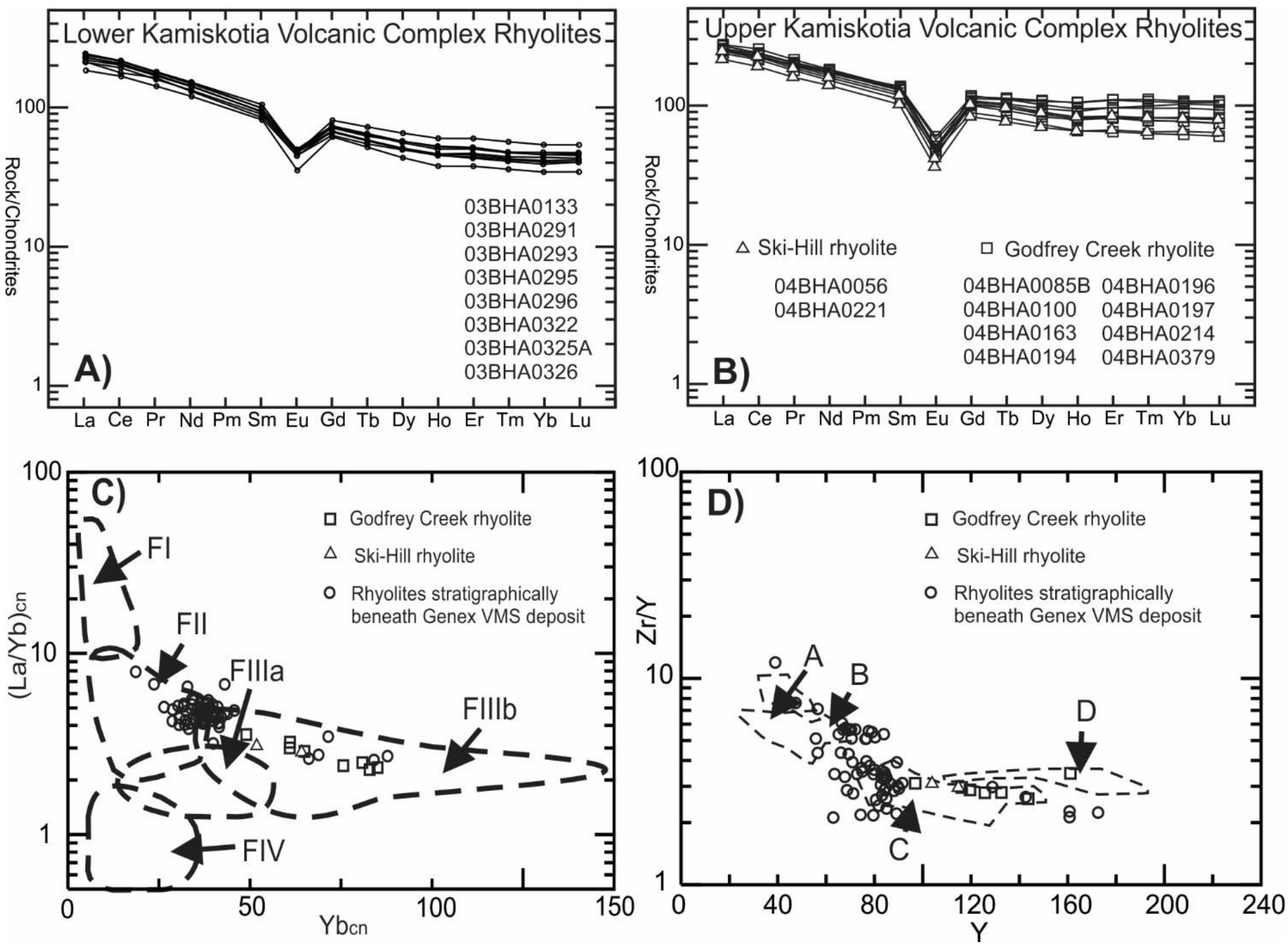

Figure 3. Lithogeochemical plots of rhyolites from the Kamiskotia area as discussed in the text. (After Hathway et al., 2008).

The ages and rhyolite chemistry of Kamiskotia Volcanic complex demonstrate correlation with the Blake River Group located about 100 km to the southeast and extending about 100 km into Quebec. Both volcanic sequences are considered to be part of a more extensive Blake River assemblage (2704-2697 Ma) (Thurston et al., 2008). Both of these Blake River assemblage sequences also have significant VMS deposits located at specific stratigraphic intervals. The ages and rhyolite chemistry of Kamiskotia Volcanic complex demonstrate correlation with the Blake River Group located about 100 km to the southeast and extending about 100 km into Quebec. Both volcanic sequences are considered to be part of a more extensive Blake River assemblage (2704-2697 Ma) (Thurston et al., 2008). Both of these Blake River assemblage sequences also have significant VMS deposits located at specific stratigraphic intervals.

Extensive geochronological studies in the Blake River Group demonstrate the range in timing and metal endowment of the Blake River Group VMS deposits (Fig. 4) as is quoted below from McNicol et. al. (2014) "Ages on host rocks of the Horne (2702.2 ± 0.9 Ma), Quemont (2702.0 ± 0.8 Ma), and Fabie (2701.9 ± 0.9 Ma) deposits reveal that they are among the oldest VMS deposits in the Blake River Group. The giant Horne Au-rich VMS deposit had already formed when the Cu-Zn deposits of the Noranda mine sequence, including Millenbach and Amulet, were generated at ~2698 Ma and is thus unrelated, consistent with its different volcanological setting and metal content. Large Au-rich VMS deposits of the Bousquet Formation, including LaRonde - Penna and Bousquet 2 - Dumagami, were formed at 2698 to 2697 Ma and are distinctly younger than the Horne and Quemont deposits. There were, therefore, two major time-stratigraphic intervals within the Blake River Group that were favorable for the formation of Au-rich VMS deposits. Rhyolite hosting the large Bouchard-Hébert VMS deposits yielded an age of 2695.8 ± 0.8 Ma."

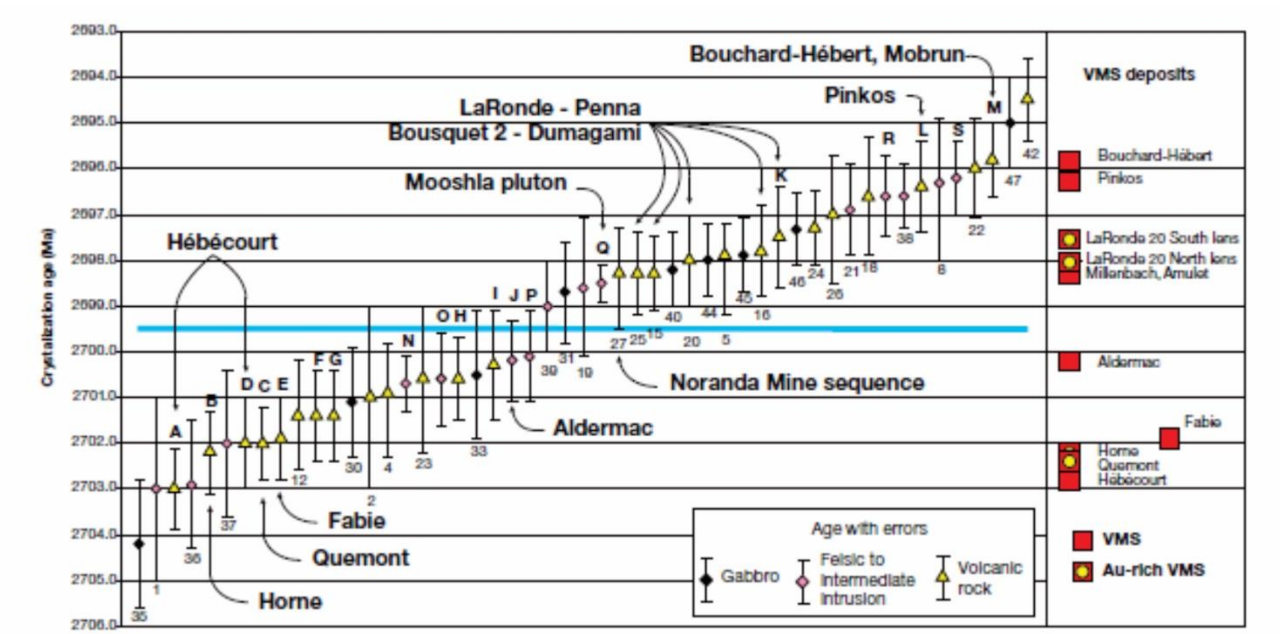

Figure 4. Distibution of U-Pb ages from the Blake River group in Quebec correlated with the timing of VMS deposits (McNicoll et al., 2014)

Kamiskotia Stratigraphic Interpretation

Good correlation between an age of 2703.1 ± 1.1 Ma in central Turnbull Township and the new age of 2703.4 ± 0.9 Ma in southern Turnbull Township provides further stratigraphic evidence that the western Kamiskotia Volcanic complex in this area is the lower member of KVC (Lower Blake River assemblage) (Fig. 1). A new age of 2699.3 ± 1.7 in northern Bristol Township correlates well with the age of 2698.6 ± 1.3 (Hathway et al., 2008) at the Genex mine, located about 6 km to the northwest. The new age data indicates that in the south, the KVC is a thick, dominantly felsic volcanic sequence which strikes southeasterly and faces to the northeast. The transition between the upper and lower members of the KVC appears to occur along a unit of high Nb basalts (Hathway et al., 2008) striking southeast from SE Turnbull into NW Bristol townships (Fig. 1). A conformable contact and an age of 2712.9 ± 0.9 in northern Carscallen Township suggests the lowermost contact of the KVC with the underlying Kidd-Munro assemblage represents a disconformity between the assemblages (see Thurston et al., 2008), in the southwest. However, the abrupt change from northeast-trending mafic volcanic rocks of the lower Kidd-Munro assemblage, with an age 2717.1 ± 2.6 Ma in an intercalated felsic volcanic unit, to lower KVC rhyolites with an age of 2699.3 ± 1.7 in northern Bristol Township Bristol indicates a fault contact between the assemblages. These newly identified upper KVC rhyolites in southern Godfrey and northern Bristol townships thus represent a good target area for discovery of VMS deposits, extending the favourable VMS stratigraphy of the upper KVC (i.e. 2700 ± 1 Ma) another 6 km south of Genex. An earlier age of 2705 ± 2 Ma from a sample located about 2.5 km southwest of the Genex Mine (Barrie and Davis, 1990) may represent some stratigraphic repetition or more likely inherited zircons in this sample. An unsuccessful attempt was made to find unanalyzed zircon fractions from this sample in the JSL archives to attempt to better understand this age; field resampling of this unit may thus be desirable.

Kidd-Munro Assemblage

The Kidd–Munro assemblage (2720–2710 Ma) is host to the Kidd Creek Mine, a giant volcanogenic massive sulfide (VMS) deposit that contains over 150 million tons of copper and zinc mineralization (Fig. 5). The assemblage extends continuously over 250 km from the Kamiskotia area into Quebec and also occurs in a number of isolated sequences throughout the Abitibi (Thurston et al., 2008). Berger et al., (2011) subdivided the Kidd–Munro assemblage into 4 distinct stratigraphic subdivisions as indicated below, based on mapping, geochemistry and an intensive campaign of high-precision U-Pb zircon geochronology. These stratigraphic subdivisions are 2720 to 2717 Ma, 2717 to 2715 Ma, 2715 to 2712 Ma and 2712 to 2710 Ma (Fig. 5). Each age is spatially restricted within the Kidd–Munro episode, has dominant rock types, volcanic morphologies, geochemical affinities and distinctive base metal prospectivity.

Rock units emplaced within the 2720 to 2717 Ma interval are composed of tholeiitic and transitional mafic, intermediate and rare felsic subaqueous metavolcanic flows and fragmental deposits that are intermixed with each other. Very little komatiite is reported within this cycle and most rocks of this age occur in Québec. Volcanic facies indicate deposition in a subaqueous environment medial to distal from volcanic vents, possibly as an oceanic plateau or back arc basin. Minor base metal mineralization is associated with rocks of this age.

The 2717 to 2715 Ma age interval is characterized by a bimodal suite of tholeiitic mafic and high silica felsic metavolcanic flows with lesser pyroclastic deposits, a komatiitic suite composed of subvolcanic dikes, sills and thick cumulate-textured flows, and a transitional suite of mafic, intermediate and felsic metavolcanic rocks. These rocks occur as intercalated units throughout the Kidd–Munro volcanic episode with the greatest concentration in the area of the Kidd Creek base metal deposit. Rare calc-alkalic rocks occur as spatially restricted mafic flows that are intercalated with mafic and intermediate tholeiitic flows.

Tholeiitic felsic metavolcanic rocks of this age are widespread and are host to VMS mineralization such as the giant Kidd Creek deposit and several smaller occurrences. Mafic magma that was erupted synchronous with the komatiite locally hosts potentially economic copper-zinc VMS mineralization (such as the Potter Mine deposit) and account for over 5 million tons of ore. This style of mineralization is poorly understood and under explored given that over 80% of the Kidd–Munro episode is composed of mafic metavolcanic rocks. Kambalda-style nickel-copper-(platinum group element) mineralization (over 500 000 tons) occurs in thick komatiite flows (sills) within footwall embayments produced by thermo-mechanical erosion and are spatially associated with peperitic komatiitic dikes and sills within this cycle. These prospective units appear to be under explored given the extent of komatiite magmatism of this age. The 2717 to 2715 Ma age bracket appears to be the most prospective for base metal mineralization in the Kidd–Munro episode.

The 2715 to 2712 Ma age interval is characterized mostly by the eruption of mafic tholeiitic lava flows with subordinate high- silica rhyolite subvolcanic sills, lava flows, autoclastic breccia and tuff. Calc-alkalic andesite and dacite pyroclastic and epiclastic deposits are restricted to a separate subunit at this interval but are still interpreted to form a single event of volcanism. A second generation of komatiite formed thin, organized lava flows typically with cumulate-textured bases and spinifex-textured tops. Kambalda-style nickel-copper-(PGE) deposits (such as the Marbridge deposit in Québec with >700 000 tons nickel-copper ore) indicate that the komatiite lava flows of this age are also fertile to host nickel sulfide mineralization. Zinc-rich VMS mineralization is hosted in some high-silica rhyolite units and calc-alkalic pyroclastic rocks and indicates a second generation of base metal mineralization, albeit minor, occurred within the Kidd–Munro episode.

Rock units with primary crystallization ages falling within the 2712 to 2710 Ma range are restricted to a few small areas and are composed mostly of tholeiitic and transitional felsic tuff, flows, epiclastic deposits and reworked metasedimentary rocks. Thin, discontinuous, spinifex- and cumulate-textured basaltic and peridotitic komatiite flows are intercalated with the felsic rocks, providing confirmation of a third komatiite generation in the Kidd–Munro volcanic episode. Minor base metal mineralization appears to be associated with this age.

Reid Township Geochronolgy

Previous geochronology samples in the Reid Township area are shown as black squares in Figure 5. They indicate that Kidd-Munro ages in Reid range from 2714.2 ± 0.5 to 2713.2 ± 1.8 Ma in the central part of the township which correlates well with the ages in the Kidd-Munro to the east. However, in the northern part of Reid and southern Mahaffy townships, ages range from 2703.0 ± 1.9 to 2700.5 ± 1.0 Ma indicating a younger stratigraphic unit which correlates with the Blake River assemblage (Ayer et al., 2005). In addition, a younger age of 2705 +5/-3 Ma in the southeastern corner of Reid Township suggested the presence of the Blake River assemblage in the southern part of Reid (Barrie and Davis, 1990). The Kidd-Munro assemblage also occurs west of the Matagami River fault in Reid, Loveland and Thornburn townships, with ages ranging from 2719.5 ± 1.7 to 2712.2 ± 2.0 Ma, but the southern contact between Kidd-Munro and the

Blake River assemblages is offset about 10 km to the south across this Proterozoic-aged sinsitral fault.

IEP geochronological samples

To better understand the boundaries of the Kidd-Munro and Blake River assemblages in northern Reid township, sample JAA-14-04 was collected from drill core at 60.8 m to 63.8 m in DDH AEM-90-03. The DDH is located northeastern Reid Township (UTN Z17; E464530, N5402050). The sample is a grey-green rhyolite flow breccia and tuff with quartz phenocrysts. Three single grain zircon fractions have been analyzed from this sample: two are in agreement on concordia (Z1, Z3), while a third (Z2) is slightly reversely discordant and younger (Fig. 6A & 6B). The two clustered analyses yield a weighted average $^{207}Pb/^{206}Pb$ age of 2701.7 ± 1.0 Ma (MSWD=1.5; p=23%), which is interpreted as the age of volcanism. The younger, reversely discordant analysis (2680 Ma) is believed to be a spurious, analytical artefact.

To better understand the Kidd-Munro and Blake River assemblage distribution in southern Reid Township, results for sample JAA-14-05 presents data from new zircon separates selected from archives stored at the JSL. The previously analyzed sample, identified as RR (and R-16), is a tuffaceous rhyolite with quartz and feldspar phenocrysts (Barrie and Davis, 1990; Barrie, 1990). On the basis of two air-abraded multigrain zircon fractions (7, 9 crystals each), and one unabraded 5-grain fraction, this sample yielded an age of 2705 +5/-3 Ma with a 90% probability of a fit. However, the model $^{207}Pb/^{206}Pb$ ages for these fractions ranged widely from 2700.7 – 2706.3 Ma and likewise showed a spread of discordance (0.15-4.3%). On the basis of the interpreted 2705 +5/-3 Ma age, the stratigraphy in this area of Reid Township was correlated with the Kamiskotia Volcanic complex located about 20 km to the southwest (Barrie and Davis, 1990). Analysis of four new zircon single grains, using modern chemical abrasion pre-treatment techniques, yields results that are more consistent, with $^{207}Pb/^{206}Pb$ ages ranging narrowly between 2700.6-2701.1 Ma (Table 1), and effectively concordant data (0.0 to -0.2% discordant). A weighted mean $^{207}Pb/^{206}Pb$ age calculated on the basis of these results is 2700.8 ± 0.8 Ma (MSWD = 0.09; prob. of fit = 96%) (Figures 6C & 6D).

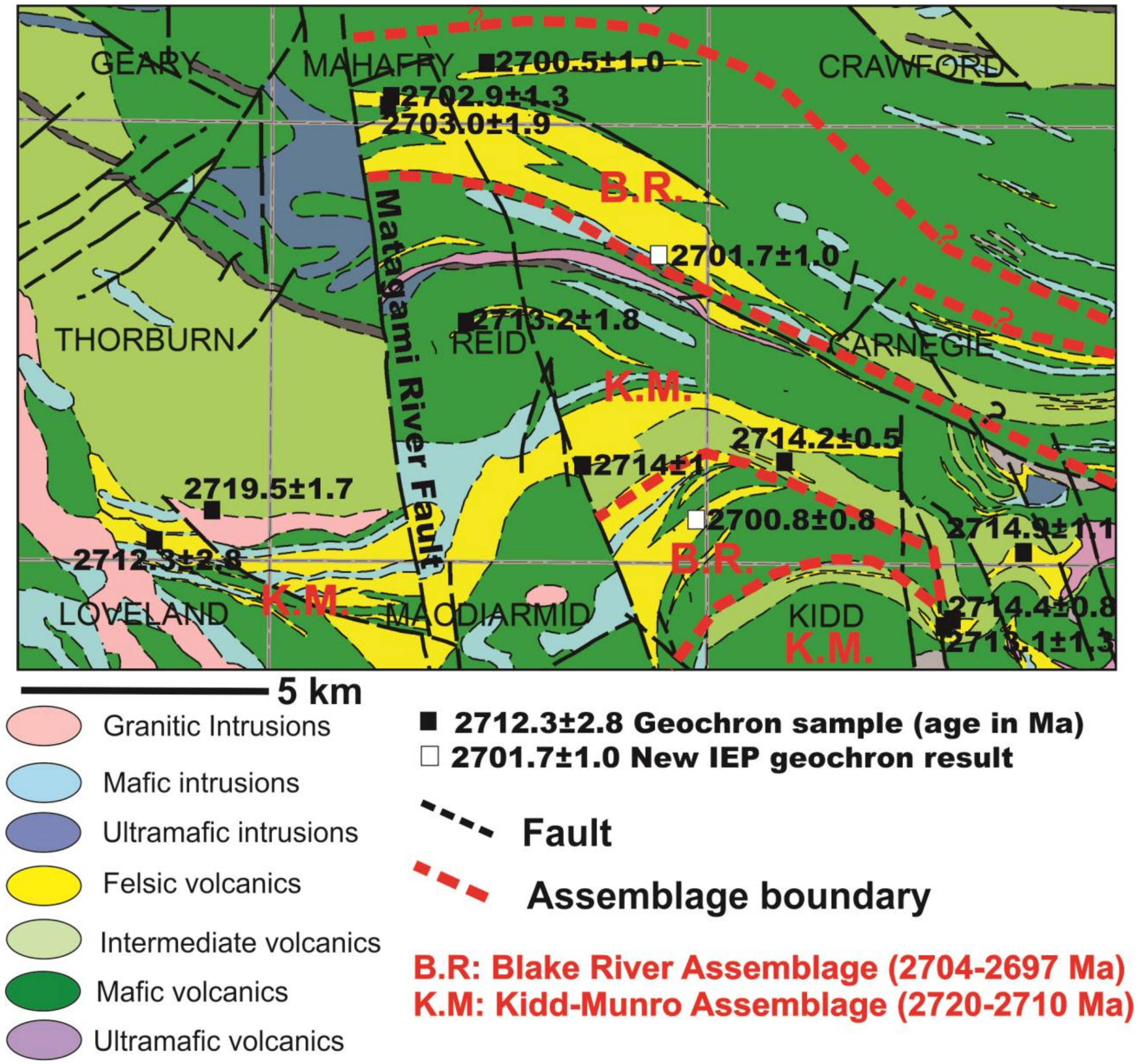

Figure 5. Reid Township area with U-Pb zircon geochronology ages (in Ma). Earlier sample locations shown in black squares, while those for new samples are shown in white squares.

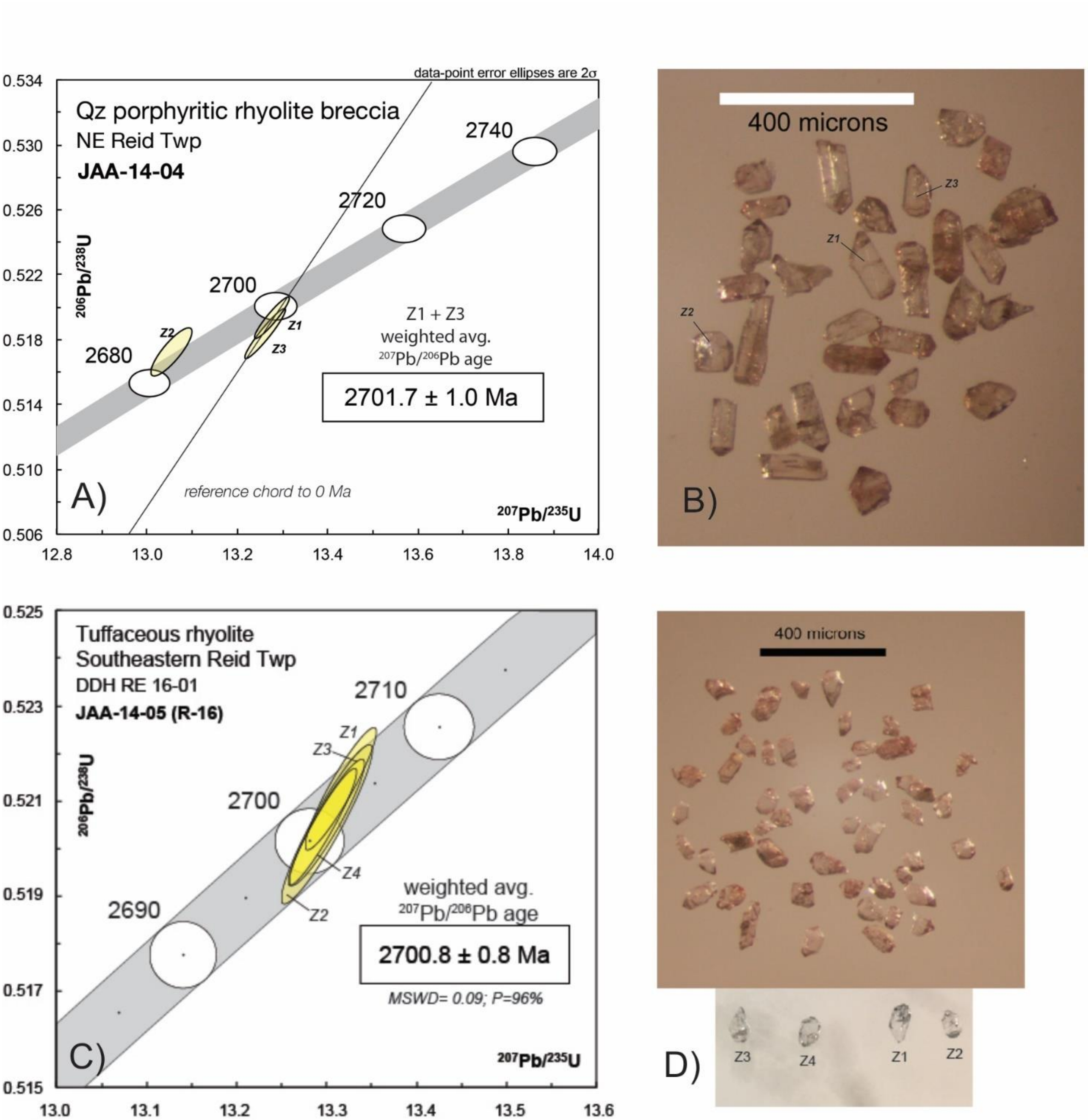

Figure 6. Concordia plots and images of selected zircons from the Reid Township area. A & B) Sample JA-14-04, C & D) Sample Ja-14-05.

Reid Township Stratigraphic Interpretation

The new ages confirm and expand the known boundaries of the Blake River assemblage in northern Reid Township (Fig. 5). A new age of 2701.7 ± 1.0 Ma in northeastern Reid indicates that the major rhyolite sequence in northern Reid and southern Mahaffy townships are part of the Blake River assemblage. In addition, slightly older ages of 2703.0 ± 1.9 and 2702.9 ± 1.3 Ma within this rhyolite sequence in southwestern Mahaffy Township, contrasting with the slightly younger upper Blake River assemblage ages of 2700.5 ± 1.0 Ma for a sample further to the north in Mahaffy, and the new sample age of 2701.7 ± 1.0 Ma in northeastern Reid, suggest an anticline occurs within this extensive sequence of rhyolites. In southeastern Reid Township the new age result of 2700.8 ± 0.8 Ma suggests in folding of the upper Blake River and the Kidd-Munro assemblages. These Blake River assemblage ages are compatible with the VMS bearing stratigraphy in the Blake River assemblage in the Kamiskotia area to the southwest (Hathway et al., 2008) and in the Blake River Group to the southeast in Québec (McNicol et. al., 2014).

The extent of Kidd-Munro assemblage in central Reid Township is now better constrained by the new Blake River assemblage ages. Ages of 2714 ± 1 and 2714.2 ± 0.5 Ma in SE Reid and SW Carnegie townships correlate well with an age of 2714.4 ± 0.8 from a rhyolite unit underlying the Chance VMS deposit in NW Kidd Township and an age of 2712.4 ± 1.9 Ma for the rhyolite unit hosting the Chance deposit (Bleeker et al., 1999) (Fig. 5). These ages, and an age of 2713.2 ± 1.8 Ma from central Reid Township indicates that this area is underlain by the 2715-2712 Ma stratigraphic subdivision of the Kidd-Munro assemblage which has good potential for zinc-rich VMS mineralization such as the Chance deposit and Kambalda-style nickel-copper-(PGE) deposits such as the Marbridge deposit in Québec (Berger et al., 2011).

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Table 1. Zircon U-Pb isotopic data for felsic volcanic rocks from the Kamiskotia area.

Fraction	Description	Sample wt. (μg)	U (ppm)	Pb^T (pg)	Pb_C (pg)	Th/U	$^{206}Pb/^{204}Pb$	$^{206}Pb/^{238}U$	± 2s	$^{207}Pb/^{235}U$	± 2s	$^{207}Pb/^{206}Pb$	± 2s	Ages (Ma) $^{206}Pb/^{238}U$	± 2s	$^{207}Pb/^{235}U$	± 2s	$^{207}Pb/^{206}Pb$	± 2s	Disc. (%)
JAA-14-01 Felsic lapillistone, Turnbull Township. DDH ETC-07-5 (97.5-99.0m).																				
Z1	1 clr, cls sml brkn pr	0.51	39	11.90	0.50	0.518	1354	0.532527	0.003016	13.69155	0.08901	0.186470	0.000472	2752.1	12.7	2728.6	6.1	2711.3	4.2	-1.8
Z2	1 clr, cls lrg 2:1 pr, incl	1.10	58	34.68	2.05	0.513	968	0.521298	0.001496	13.33928	0.06974	0.185586	0.000639	2704.7	6.3	2704.0	4.9	2703.4	5.7	-0.1
Z3	1 clr, cls, el, sl flat	0.49	55	16.60	1.96	0.527	492	0.526241	0.002385	13.44741	0.11308	0.185333	0.001050	2725.6	10.1	2711.6	8.0	2701.2	9.4	-1.1
Z4	1 clr, cls, el, sq, brkn	0.82	56	28.29	0.78	0.799	1934	0.519887	0.001045	13.30156	0.03047	0.185560	0.000191	2698.7	4.4	2701.3	2.2	2703.2	1.7	0.2
Z5	1 clr, cls, el rect, brkn	0.63	50	18.35	0.84	0.624	1224	0.520655	0.001209	13.32412	0.03672	0.185605	0.000248	2702.0	5.1	2702.9	2.6	2703.6	2.2	0.1
JAA-14-03 Felsic-intermediate, heterolithic lapilli tuff to breccia, Bristol Township. DH EB ... -00-01 (23 ... .7-238.2m).																				
Z1	1 clr, cls, lrg 2.5:1 shrp pr, incl	0.95	122	75.05	0.66	0.685	6224	0.519552	0.001134	13.30875	0.03364	0.185783	0.000209	2697.3	4.8	2701.8	2.4	2705.2	1.9	0.4
Z2	1 clr, cls, brkn shrt shrp pr, incl	0.52	97	28.88	0.30	0.545	5326	0.520062	0.001457	13.27452	0.04183	0.185124	0.000181	2699.4	6.2	2699.4	3.0	2699.3	1.6	0.0
Z3	1 clr, cls, sl flat, 2:1 shrp pr, incl	1.03	75	44.36	0.51	0.548	4864	0.516022	0.001205	13.20084	0.03651	0.185538	0.000186	2682.3	5.1	2694.1	2.6	2703.0	1.7	0.9
Z4	1 clr, cls, 4:1 shrp brkn, incl	0.61	84	30.46	0.80	0.637	2113	0.515005	0.001432	13.13210	0.04559	0.184936	0.000284	2678.0	6.1	2689.2	3.3	2697.6	2.5	0.9
JAA-14-04 Quartz porphyritic rhyolite breccia, NE Reid Township.																				
Z1	1 gemmy, crkd, 2.5:1 sq pr	1.02	149	93.13	0.44	0.764	11321	0.519486	0.001030	13.27449	0.03156	0.185329	0.000164	2697.0	4.4	2699.4	2.2	2701.1	1.5	0.2
Z2	1 gemmy, crkd, brkn sq pr frag	0.98	105	62.71	1.32	0.554	2670	0.517392	0.001201	13.05411	0.03723	0.182989	0.000283	2688.1	5.1	2683.6	2.7	2680.2	2.6	-0.4
Z3	1 gemmy, crkd, 2:1 sq pr, incl	0.59	140	50.40	0.46	0.592	6129	0.518520	0.001253	13.26009	0.03725	0.185472	0.000173	2692.9	5.3	2698.3	2.7	2702.4	1.5	0.4
JAA-14-05 Quartz and feldspar phenocryst-bearing tuffaceous rhyolite, SE Reid Township.																				
Z1	1 clr, cls, 2:1 shrp pr, incl	1.15	126	75.87	0.61	0.573	6900	0.521284	0.001038	13.31619	0.03227	0.185270	0.000173	2704.6	4.4	2702.3	2.3	2700.6	1.5	-0.2
Z2	1 clr, cls, shrt pr, incl	0.85	114	34.55	0.57	0.608	3344	0.520546	0.001347	13.30108	0.04089	0.185322	0.000213	2701.5	5.7	2701.3	2.9	2701.1	1.9	0.0
Z3	1 clr, cls, 2:1 brkn pr	1.12	128	78.89	0.96	0.675	4468	0.520592	0.001067	13.30155	0.03398	0.185312	0.000187	2701.7	4.5	2701.3	2.4	2701.0	1.7	0.0
Z4	1 clr, cls, short, sl flat, shrp pr	1.05	180	113.69	0.48	0.823	12445	0.520488	0.000993	13.29576	0.03093	0.185268	0.000156	2701.3	4.2	2700.9	2.2	2700.6	1.4	0.0

Notes:

All analyzed fractions represent best optical quality (crack-, inclusion-, core-free), fresh (least altered) grains of zircon available. All zircons were chemically abraded.

Abbreviations: Z - zircon fraction; clr - clear; cls - colourless; fr - fragment; pr - prism/prismatic; el - elongate; sl - slightly; sml - small; lrg - large; sq - square x-section; shrp - sharp; brkn - broken; rect - rectangular; incl - inclusion-bearing.

Pb^T is total amount (in picograms) of Pb.

Pb_C is total measured common Pb (in picograms) assuming the isotopic composition of laboratory blank: 206/204 - 18.221; 207/204 - 15.612; 208/204 - 39.360 (errors of 2%). Pb/U atomic ratios are corrected for spike, fractionation, blank, and, where necessary, initial common Pb; 206Pb/204Pb is corrected for spike and fractionation.

Th/U is model value calculated from radiogenic 208Pb/206Pb ratio and 207Pb/206Pb age, assuming concordance. Disc. (%) - per cent discordance for the given 207Pb/206Pb age. Uranium decay constants are from Jaffey et al. (1971).