Horizonte Minerals Plc

Amended NI 43-101 Technical Report on the Serra do Tapa Project, Pará State, Brazil

3 September 2019

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1 SUMMARY

1.1 Introduction

This National Instrument 43-101 (NI 43-101) Technical Report describes the Serra do Tapa Nickel Project (SDT or "the Project"), an advanced mineral exploration area located near Carajás, in the State of Pará, Brazil. The Project is located approximately 600 kilometres (km) south of the Pará state capital of Belém. The Project is wholly owned by Horizonte Minerals Plc (HZM or "the Company").

On 13 August 2019, HZM reported via the Alternative Investment Market (AIM) and Toronto Stock Exchange (TSX) press release, a summary of the Mineral Resource Estimates for SDT and this is the trigger for this Technical Report (Horizonte 2019a).

1.2 Property description and ownership

The SDT licence is described by the Departmento Nacional de Produção Mineral (ANM) process 850514/2003 and covers 6,052.28 hectares (ha). On 28 September 2015, the licence was acquired by HZM through its Brazilian subsidiary, following indirect acquisition from Xstrata Brasil Exploração Mineral Ltda (a wholly owned subsidiary of Glencore Canada Corporation (Glencore)).

The mineral rights phase is at the end of the first stage (Exploration), i.e. pending a decision by the ANM regarding the "Relatório Final de Pesquisa" (RFP) or Final Exploration Report submitted by HZM on 17 November 2017.

The property can be easily reached via unpaved roads (65 km) from the PA-155 main highway that runs from Marabá to the north and Redencão in the south. Alternatively, the property can be accessed from Araguaína (State of Tocantins) via the TO-222 a surfaced road to the Araguaia River, then ferry across the Araguaia River to Vila São José followed by 45 km of unsurfaced road to the property.

The Carajás Mining District contains major iron ore, manganese, copper, and gold deposits as well as lead-zinc, nickel, bauxite and cassiterite. It is considered to be the most important mining district in the country and as such has seen a vast amount of investment and development since the 1970s.

The SDT permit area is characterised by undulating hill systems with elevated plateaus and ridge features separated by shallow valleys ranging in elevation from 280 m above sea level (ASL) to 500 m ASL. The SDT nickel laterite deposit is located on an elevated plateau. Most of the low-lying area is cleared of vegetation for open paddock cattle grazing.

The original vegetation is the equatorial latifoliated forest, with transitions to a tropical forest, dominated by low and medium size plants, and locally with very tall trees. At higher elevations, Cerrado or savanna type wooded grassland with low to medium size plants is encountered. However, several decades ago, much of the lower lying area has been deforested, and is currently used for agriculture.

1.3 Geology and mineralisation

The SDT deposit lies within the Neoproterozoic Araguaia Fold Belt. This belt is a large north to south trending orogenic zone along the contact of the Amazon Craton to the west and the São Francisco Craton to the east. The Belt is 1,000 km long and 150 km wide and its evolution is believed to be contemporary with the Brazilian thermal event at the Neoproterozoic boundary.

The belt comprises metamorphosed and deformed marine-clastic sediments of the Tocantins Group and can be split into two halves based on the degree of metamorphism present. The more highly metamorphosed Estrondo Formation comprises the eastern half of the belt while the western half displaying lower levels of metamorphism is termed the Couto de Magalhães Formation.

The Estrondo Formation is dominated by greenschist to amphibolite facies grade metamorphosed sediments with occasional banded iron formations, carbonates and exposures of Archaean basement. Proterozoic granites intrude the eastern belt. The Couto de Magalhães Formation contains weakly metamorphosed, marine pelites with local carbonate, iron-rich, and mafic to ultramafic bodies.

The SDT deposit is orientated in a north-south direction. The mineralised portion extends for some 5,000 m (north-south) and is up to 900 m in width. A distinctive lateritic sequence is developed over ultramafic and mafic rocks. The sequence can be split into six main facies types: soil, ferricrete, limonite, transition, saprolite and fresh rock, as well as numerous sub-facies.

Discrimination between the geological horizons is made using mainly iron, magnesium oxide, silica, alumina and nickel grades. The mineralised geological horizons are designated 100 (Limonite), 200 (Transition) and 300 (Saprolite).

1.4 Status of exploration, development and operations

The first recognised reconnaissance work at SDT was completed by Companhia de Pesquisa de Recursos Minerais (CPRM) in the 1970s. It was not until 2003 that the area was reviewed in more detail when Falconbridge Brazil Ltda or Falconbridge (which then became Xstrata Nickel in 2006), evaluated the data generated by CPRM and realised that the area displayed the potential to host nickel laterite deposits. Xstrata Nickel continued the evaluation with an accelerated period of investigative work from 2004 until 2007 including extensive drilling programs coupled with detailed geological mapping. No field activities have occurred at SDT since 2007.

1.5 Mineral Resource estimates

Snowden completed the Mineral Resource Estimate (MRE) for SDT in 2016. At a cut-off grade of 0.90% Ni, a total of 14.2 Mt at a grade of 1.31% Ni is reported as a Measured Mineral Resource and a total of 56.0 Mt at a grade of 1.20% Ni is reported as an Indicated Mineral Resource, in accordance with the Definition Standards (CIM, 2014). This gives a combined tonnage of 70.2 Mt at a grade of 1.22% Ni for Measured and Indicated Mineral Resources using a cut-off grade of 0.90% Ni. A further 2.6 Mt at a grade of 1.14% Ni is defined as an Inferred Mineral Resource at a cut-off grade of 0.90% Ni. The Mineral Resource is summarised in Table 1.1.

Table 1.1 SDT classified Mineral Resource report above 0.9% Ni cut-off

Classification	Tonnage (Mt)	Ni (%)	Ni metal (kt)	Co (%)	Fe (%)	SiO_2 (%)	MgO (%)
Measured	14.3	1.31	188	0.05	16.4	41.3	18.1
Indicated	56.0	1.20	670	0.05	17.0	40.6	17.9
Measured + Indicated	**70.3**	**1.22**	**857**	**0.05**	**16.9**	**40.8**	**17.9**
Inferred	2.7	1.14	31	0.06	22.3	35.9	12.3

1.6 Conclusions and recommendations

The SDT licence acquired by HZM is near the Carajás Mining District, an active mineral exploration and mining region with advanced infrastructure and services to support the development of SDT. The previous operator had completed a Scoping Study to evaluate the production of nickel from open pit mining and processing via pyrometallurgical methods.

Field investigation undertaken between 2003 and 2007 by Falconbridge, and later Xstrata, provides a good geological understanding of the investigated area. The resulting geological knowledge together with the quality of data obtained from the drill program to 2007 is the basis for the historic mineral resources quoted by Glencore-Xstrata in 2013.

Geological mapping conducted along with the drilling campaigns has been focused on determining the limits of laterite developments and identification of the limonite, transition and saprolite horizons, is considered to provide a fair and reasonable representation of the geology of SDT.

Some basic environmental data has been collected previously that remains valid and can be used by HZM to design a full baseline program. The previous socio-environmental studies carried out at SDT will be useful to guide new social and environmental studies in the region.

HZM has recently completed a feasibility study (FS) on its Araguaia Nickel Project (ANP) located approximately 150 km to the south of SDT and is proposing open pit mining from numerous deposits and processing via the Rotary Kiln Electric Furnace (RKEF) method. Additionally, in 2017, HZM purchased the Vermelho nickel-cobalt project approximately 80 km to the northwest of SDT and plans to complete a prefeasibility study (PFS) in Q3, 2019 (HZM, 2019b). Consequently, HZM is familiar with the region and is well placed to consider synergies that may exist in the development of the ANP, SDT and Vermelho projects.

MREs are deemed “current” and are reported in conformance with CIM Definition Standards (CIM, 2014).

The author recommends that HZM should complete a review to ascertain the preferred strategy for incorporating SDT into HZM’s other planned projects.

2 INTRODUCTION

2.1 Overview

This report is a NI 43-101 Technical Report on the MRE of the HZM wholly owned Serra do Tapa Project. The deposit is located in the region of Carajás, in the State of Pará, Brazil; approximately 600 km south of the state capital Belém. The acquisition of the Project was announced by HZM on 28 September 2015 (HZM, 2015), disclosing an agreement with Glencore, the then owner, to acquire 100% of the Project.

This report has been compiled by the author and Snowden Mining Industry Consultants (Snowden) for HZM. HZM is the Project owner and is currently developing the Project. This report provides MREs, and a classification of resources prepared in accordance with CIM Definition Standards (CIM, 2014).

Unless otherwise stated, information and data contained in this report or used in its preparation has been provided by HZM.

The information, conclusions, opinions, and estimates contained herein are based on:

- Information available to Snowden at the time of compiling this Technical Report, including previous Technical Reports prepared on the Project and associated licences within the Project
- Assumptions, conditions, and qualifications as set forth in this Technical Report
- Data, reports, and other information supplied by HZM and other third-party sources.

The Qualified Person and Snowden have not carried out any independent exploration work, drilled any holes or carried out any sampling and assaying on the Project. The Qualified Person for preparation of the report is Andrew F. Ross, who visited the Project site on 6 and 7 August 2019.

2.2 Issuer – Horizonte Minerals Plc

HZM is an AIM and TSX-listed nickel development company focused on Brazil which wholly owns the advanced Araguaia ferronickel project (ANP). The Company is planning to develop the ANP into a major ferronickel mine in Brazil, with targeted production in 2021. The ANP is divided into a northern sector (ANN) and southern sector (ANS). The SDT forms part of the historical ANN sector where Glencore (formerly as Falconbridge-Xstrata) undertook exploration work.

HZM also has a 100% interest in the Vermelho project, acquired from Vale S.A. in December 2017. Vale S.A. completed a full FS which demonstrated a nameplate capacity of 46,000 tonnes of nickel per year and 2,500 tonnes of cobalt per year. HZM plans to complete a PFS in Q3, 2019 for the Vermelho project (HZM, 2019b).

The Company was founded on 16 January 2006, with shares listed on the Alternative Investment Market of the London Stock Exchange (AIM) and on the Toronto Stock Exchange (TSX). HZM is incorporated and domiciled in the United Kingdom, with a registered office at Rex House, 4-12 Regent Street, London SW1Y 4RG.

As of 19 August 2019, the Company's institutional shareholder structure included Teck Resources Limited, Canaccord Genuity Group, Richard Griffiths, Lombard Odier Asset Management (Europe) Limited, JP Morgan, City Financial, Hargreaves Lansdown and Glencore.

2.3 References

All references are listed in Section 27.

2.4 Units, currency and abbreviations

Unless otherwise stated, all currencies are expressed in US dollars (US$).

The co-ordinate system for SDT is the Zone 22 UTM S-America Datum 1969 (UTMSAD69). Abbreviations and units are shown below (Table 2.1).

Table 2.1 Abbreviations and unit of measurement

Abbreviation/Unit of measurement	Description
%	percent
°	degrees
°C	degrees Celsius
3D	three-dimensional
AIM	Alternative Investment Market of the London Stock Exchange
Al_2O_3	aluminum oxide
ANM	Departmento Nacional de Produção Mineral
ANN	Northern section of Araguaia Nickel Project
ANP	Araguaia Nickel Project
ANS	Southern section of Araguaia Nickel Project
AusIMM	Australasian Institute of Mining and Metallurgy
CaO	Calcium oxide
capex	capital expenditure
CIM	Canadian Institute of Mining, Metallurgy and Petroleum
cm	centimetre(s)
Co	cobalt
Contemat	Contemat Ltda
CP	Competent Person
CPRM	Companhia de Pesquisa de Récusons Minerais
Cr_2O_3	chromium trioxide
Cu	Copper
CV	Coefficient of Variation
DC	direct current
DD	diamond drilling
Eh	Activity of electrons
EIA RIMA	Social and Environment Impact Assessment
EPMA	electron probe microanalysis
Falconbridge	Falconbridge Brazil Ltda
FS	feasibility study
g	gram(s)
g/cm^3	grams(s) per cubic centimetre
Geoserv	Geoserv-Boart Longyear
Glencore	Glencore Canada Corporation
Glencore-Xstrata	A merger of Glencore International and Xstrata plc, completed in May 2013
GPS	global positioning system
h	hour(s)
ha	hectare(s)
HSEC	health, social, environment, and community
HZM (or “the Company”)	Horizonte Minerals Plc
IBGE	Instituto Brasileiro de Geografia e Estatística

Abbreviation/Unit of measurement	Description
ID	Identification
JORC	Joint Ore Reserves Committee
JORC Code, 2012	The current Australasian Code for the reporting mineral resources and ore reserves (the JORC Code, 2012 edition)
kg/hr	kilogram(s)
kg/hr	kilograms per hour
km	kilometre(s)
kt	thousand tonnes
kW	kilowatt
kW/m^2	kilowatt per square metre
LI	Installation Licence
LIMS	laboratory information management system
LO	Operation Licence
LOI	loss on ignition
LP	Preliminary Licence
m	metre(s)
m^2	square metre(s)
m^3	cubic metres(s)
MgO	magnesium oxide
mℓ	millilitre(s)
MnO	manganese oxide
mm	millimetre(s)
MRE	Mineral Resource estimate
mRL	Reduced level/ depth or height of a place (in m) above a reference datum or mean sea level
Mt	million tonnes
Ni	nickel
NI 43-101	National Instrument 43-101
NPI	blast furnace nickel pig iron
NST	nickel smelting technology
opex	operating expenditure
P_2O_5	phosphorus pentoxide
PAE	Plano de Aproveitamento Econômico da Jazida/ economic development plan
PCA	Environmental Control Plan
PFS	prefeasibility study
pH	Activity of hydrogen ions
ppm	parts per million
PP	Pau Preto
QA	quality assurance
QA/QC	quality assurance/quality control
QC	quality control
QEMSCAN	quantitative evaluation of materials by scanning electron microscopy
RC	reverse circulation
Rede	Rede Ltda
RFP	Relatório Final de Pesquisa / Final exploration report
RKEF	rotary kiln electric furnace
RPP	Relatório Parcial de Pesquisa/ Partial Exploration Report
SAD69	Regional geodetic datum for South America in 1969

Abbreviation/Unit of measurement	Description
SD	standard deviation(s)
SDT (“the Project”)	Serra do Tapa Nickel Project
SEMAS	State Environmental Agency
Servitec	Servitec Ltda
SiO_2	silicon dioxide (silica)
Snowden	Snowden Mining Industry Consultants Pty Ltd
t	tonne(s)
t/m^3	tonnes per cubic metre
TAM	TAM Brazilian Airlines
TiO_2	titanium dioxide
TSX	Toronto Stock Exchange
µm	micron
US$	United States dollars
V_2O_5	vanadium oxide
VDS	Vale dos Sonhos
Vermelho (or “the Project”)	Vermelho Nickel-Cobalt Project
XRD	x-ray diffraction
XRF	x-ray fluorescence
Xstrata	Xstrata Brasil Exploracao Mineral Ltda
Xstrata Nickel	One of Xstrata plc’s global commodity businesses. Entity was headquartered in Toronto, Canada.

3 RELIANCE ON OTHER EXPERTS

The Qualified Person has relied upon the legal and environmental information provided by the following employees of HZM for inclusion in Section 4 (Property Description and Location):

- Mr Steven Heim, on 7 January 2018, provided an overview of mining legislation (Section 4.2.1) and tenement details (Section 4.2.2).

For the purposes of this report, Snowden has relied on ownership and title information provided by HZM. Snowden has not researched property title or mineral rights for the Project and expresses no opinion as to the ownership status of the property. The description of the property, and ownership thereof, as set out in Section 4 in this technical report, is provided for general information purposes only.

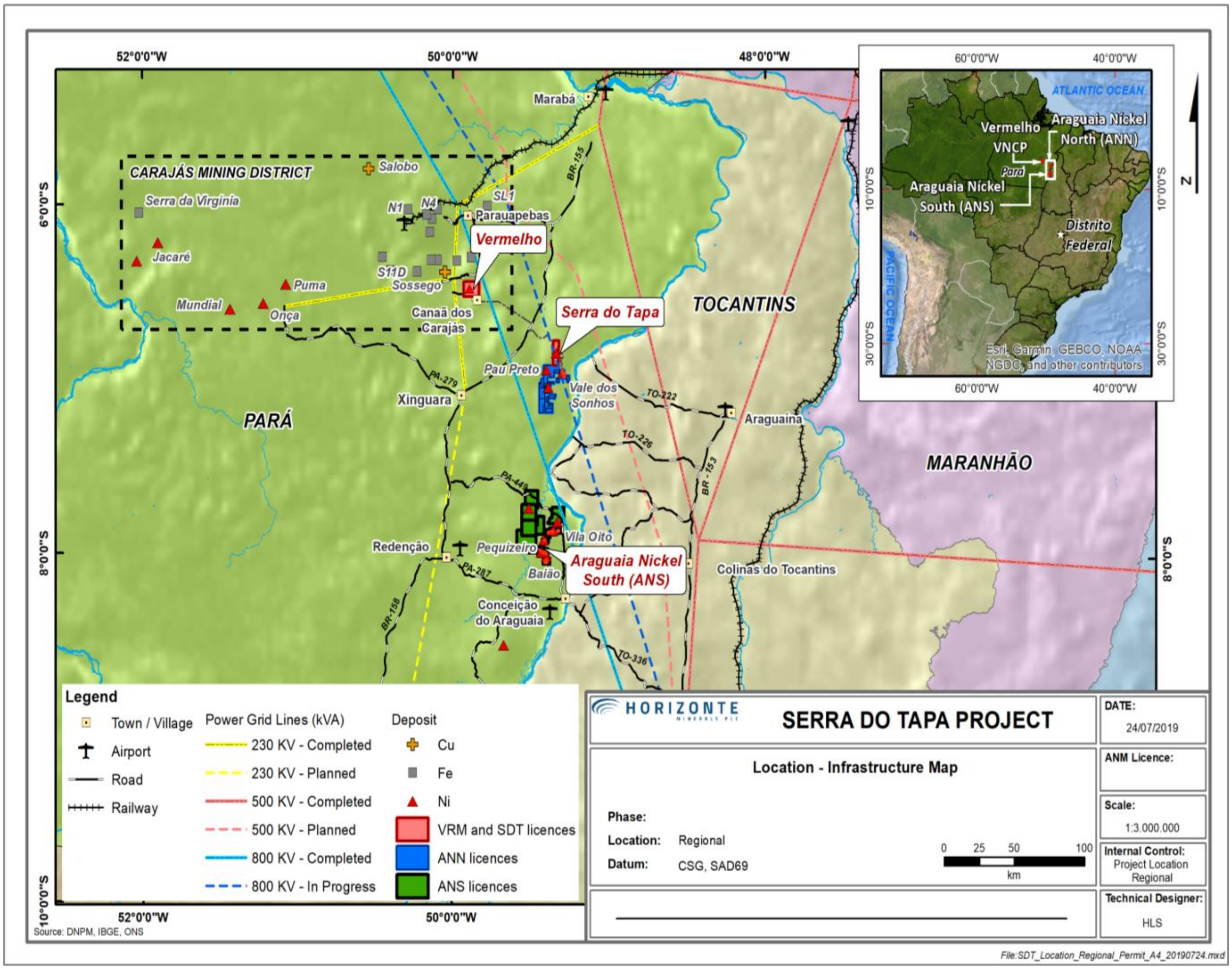
Except for the purposes legislated under provincial securities laws, any use of this report by a third party is at that party's sole risk.

4 PROPERTY DESCRIPTION AND LOCATION

4.1 Location

SDT is located 80 km southeast of Canaã dos Carajás and 65 km to the east of the town of Xinguara in the municipality of Xinguara (Figure 4.1).

Figure 4.1 Location map



Source: HZM, 2019c

4.2 Licences and tenure

Brazil has a well-established permitting process for major mining projects, with a Mining Code and environmental legislation framework (CONAMA), which provides the support for companies to operate legally in the country.

HZM has operated for many years in Brazil with current exploration licences from both mining and environmental agencies across all target areas.

4.2.1 Mining legislation overview

The main sources of mining legislation in Brazil are the Federal Constitution and the Mining Code (Decree-law no. 227 of 28 February 1967). The Mining Code defines and classifies deposits and mines, sets requirements and conditions for obtaining authorizations, concessions, licences and permits, the rights and duties of holders of exploration licences and mining concessions. There are two main legal regimes under the Mining Code regulating exploration and mining, i.e. the “authorization” for exploration and the “concession” for mining.

Exploration, which is defined by the Mining Code as the work required to locate and define a deposit and determination of the economic feasibility thereof, can be carried out through an authorization from the Federal Government. The exploration authorization is granted through a licence issued by the Director General of the “Agencia Nacional de Mineração”, or ANM as it is commonly referred to. ANM, previously known as “Departamento Nacional de Produção Mineral” or DNPM, is the federal agency in charge of implementing the country’s exploration and mining, fostering the mining industry, granting and managing exploration and mining titles and monitoring the activities of exploration and mining companies.

Exploration licences may be for areas up to 10,000 ha and be granted for a period of up to three years depending on the substance being sought. Nickel qualifies for up to the maximum area and three years. The term (three years) can be renewed once, at the discretion of the ANM, upon its review of an interim Partial Exploration Report (“Relatório Parcial de Pesquisa” (RPP)) from the licence holder regarding exploration conducted to date which justifies further exploration. Prior to the termination of the exploration licence, be it the initial three-year period or in the case of renewal its second three-year period the holder must submit a “Relatório Final Único De Pesquisa” (RFP), the Final Exploration Report, on the results of the work to ANM. ANM may then decide to:

- Approve the report, when it shows the existence of a resource which can be both technically and financially developed
- Dismiss the report, when the exploration work undertaken was insufficient or due to technical deficiencies in the report
- File the report, when it has been proved that there was no deposit which may be both technically and/or financially developed
- Postpone a decision on the report in the event the existence of a resource has been demonstrated, but for technical and/or financial reasons development of the property is not feasible at the time.

The decision to postpone a decision on the Final Exploration Report is referred to as “Sobrestamento”. With this decision ANM will fix a period in which the interested party will be required to submit a new technical-financial FS of the deposit. This is normally a three-year period (decree-portaria 21/97). The penalty for not meeting the deadline will be the archiving of the RFP and liberation of the area. If the new study does not demonstrate technical-financial feasibility, ANM may grant the interested party an extension to the time limits or open a tender process for the licence if they believe there are third parties who could feasibly mine the deposit. If the new study demonstrates technical-economic feasibility, the RFP will be approved, and the holder of the licence will have one year to apply for a mining concession. An extension of one year can be requested in applying for the mining concession.

If the licence holder does not apply for the mining concession within the period mentioned above, the mineral rights over the property will lapse and the area becomes available for tender offers for 60 days, during which period any interested parties, including the previous licence holder, may submit their offers for an exploration licence or mining concession. The ANM will review the offers and will select the bid that, in its view, presents the most favourable conditions to meet the interests of the mineral sector. If no offers are submitted within the 60-day period, the area will then be considered as available for future applications for exploration licences under the priority system described above.

The application for a Mining Concession must be accompanied by the following information:

- I – The company's certificate of registration from the Board of Trade.
- II – Identification of mineral substances to be mined, with a copy of the exploration permit and the approval of the RFP.
- III – Name and description of the area intended for development, clearly and accurately reporting all river valleys or streams identified on maps or charts of known authenticity and exactitude; all railways and highways or any natural or topographical features of unmistakable determination; boundary lines with neighbouring Exploration Consents and Exploitation Consents if any; and the identification of the District, Municipality, Circuit, and State; as well as the name and residential address of the owners or possessors of the land.
- IV – A graphic depiction of the intended area, circumscribed by a geometric figure formed by straight lines with a true north-south and east-west orientation, with two of their vertices, or in exceptional cases, one, anchored to a fixed, unmistakable point of the land, with the vectors defined by their lengths and true bearings, and showing the properties covered, indicating the names of the respective holders of rights to the surface of the soil, in addition to the site plan.
- V – Easements that apply to the mine.
- VI – Economic development plan of the deposit, with a description of the beneficiation plant.
- VII – Proof of the availability of funds or the existence of financial commitments necessary for the execution of the economic development plan and mining operations.

The economic development plan of the deposit known as the "Plano de Aproveitamento Econômico da Jazida" (PAE) consists of:

- I – A descriptive report.
- II – Pertinent designs or preliminary plans:
  - the mining method to be adopted, referring to the initially forecasted production scale and its projection
  - the lighting, ventilation, transportation, signalling and work safety plans in the case of underground mining
  - the surface transportation, beneficiation, and stockpiling of the ore
  - the power installations, water supply, and air conditioning
  - the hygiene of the mine and respective work
  - the housing facilities and their habitability for all who live in the mining area
  - the installations for the supply and protection of the origin, storage, distribution, and use of water for Class VIII deposits.

The design of the installations and equipment referred to in the economic development plan shall be consistent with the production justified in the descriptive report and include a forecast for future expansions.

The Mining Concession will be denied if the development is considered by the Government to be prejudicial to the public welfare or compromises interests that transcend the use of the industrial exploitation. In the latter case, the explorer shall have the right to receive indemnification from the Government for expenses spent on the exploration work, once the RFP has been approved.

The holder of a mining concession must inter alia: (i) commence development within 180 days from the granting of the concession, subject to obtaining all required environmental licences and authorizations; (ii) refrain from suspending development and mining operations for more than six months without the prior approval of the ANM; (iii) mine according to the mining plan approved by the DNPM; (iv) compensate the landowner for occupation of the property; (v) pay a royalty to the landowner; (vi) pay a royalty to be distributed among the local, state and federal governments; (vii) obtain all required environmental licences and authorizations; (viii) restore the areas degraded by mining and processing operations and infrastructure; (ix) report annually to the ANM on activities, production and sales.

Mining concessions may be transferred (in whole or in part) to legal entities incorporated in Brazil, if the transferee demonstrates technical and financial capability to the ANM. The transfer is subject to the approval of and registration by the ANM. Furthermore, mining concessions can also be encumbered, e.g. because of a judicial order or as a security. The mining concession may be relinquished by its holder at any time. In such event, the holder will, at the discretion of ANM, be able to remove its property from the mine location provided that no damage is caused to the mine.

In general, mining projects must undergo a three-stage environmental licensing process. Generally, the State environmental authority oversees licensing a mining project for projects contained within one State, as opposed to the Federal environmental authority (IBAMA) whom are responsible for licensing mining projects across state borders. The Federal environmental authority will be in charge whenever mining activities will be undertaken in, or cause an impact on, areas deemed as federal, such as national environmental conservation units, as well as in cases where mining activities will be executed in two or more States. The compliance with all applicable environmental laws includes, but is not limited to, the possession by mining companies of all permits and other governmental authorizations required under applicable environmental laws, and compliance with the terms and conditions thereof, including the authorizations granted to impound water and exploit forest resources.

A Preliminary Licence (LP) must be obtained at the planning stage of the mining project. A Social and Environment Impact Assessment (“EIA RIMA”) and a plan for the restoration of degraded areas must be prepared at this stage. Public hearings are usually called to present the EIA RIMA to the communities and authorities. Following the public hearing, the State Environmental Agency (SEMAS) may or may not approve the issue the LP. The LP usually imposes conditions that must be complied with by the mining company. By granting the LP, the environmental authority acknowledges that the project is environmentally acceptable. At this stage, the environmental authority will also set the amount of the environmental compensation, which is a minimum of 0.5% of the projected development investment.

The second stage of the environmental licensing process is the Installation Licence (LI) stage. During this stage the mining company must produce an Environmental Control Plan (PCA), among other documents and submit it to the environmental authorities. Once the PCA is approved, the LI is granted, usually under certain conditions. The mining company may start construction of the mine, plant and infrastructure. A mining concession can only be granted by the Minister of Mines once the mining company has obtained the LI.

The last stage of the environmental licensing process is the one related to the Operation Licence (LO). The LO is granted once the environmental authorities are satisfied that the development and construction were completed in accordance with all the conditions of the LI and that the PCA is correctly implemented. The LO authorises a mining company to mine, process and sell (as well as other ancillary activities that may be described in the licence), from an environmental viewpoint. It is possible to renew the LO if the request is presented 120 days (or another period set by specific regulations) before the expiry date of the last permit. In that case, the LO is automatically extended until the environmental agency discloses its final decision about the request.

4.2.2 SDT licence

In September 2015, the licence was acquired by HZM through its Brazilian subsidiary following indirect the acquisition from Xstrata Brasil Exploracao Mineral Ltda (Xstrata), a wholly owned subsidiary of Glencore Canada Corporation (Glencore).

As shown in Table 4.1, the licence is in good standing. The date shown in column 6 represents the most recent ANM reporting or other action to be taken for the process. The mineral rights phase is at the end of the first stage (Exploration), i.e. pending a decision by the ANM regarding the RFP submitted by HZM on 17 November, 2017.

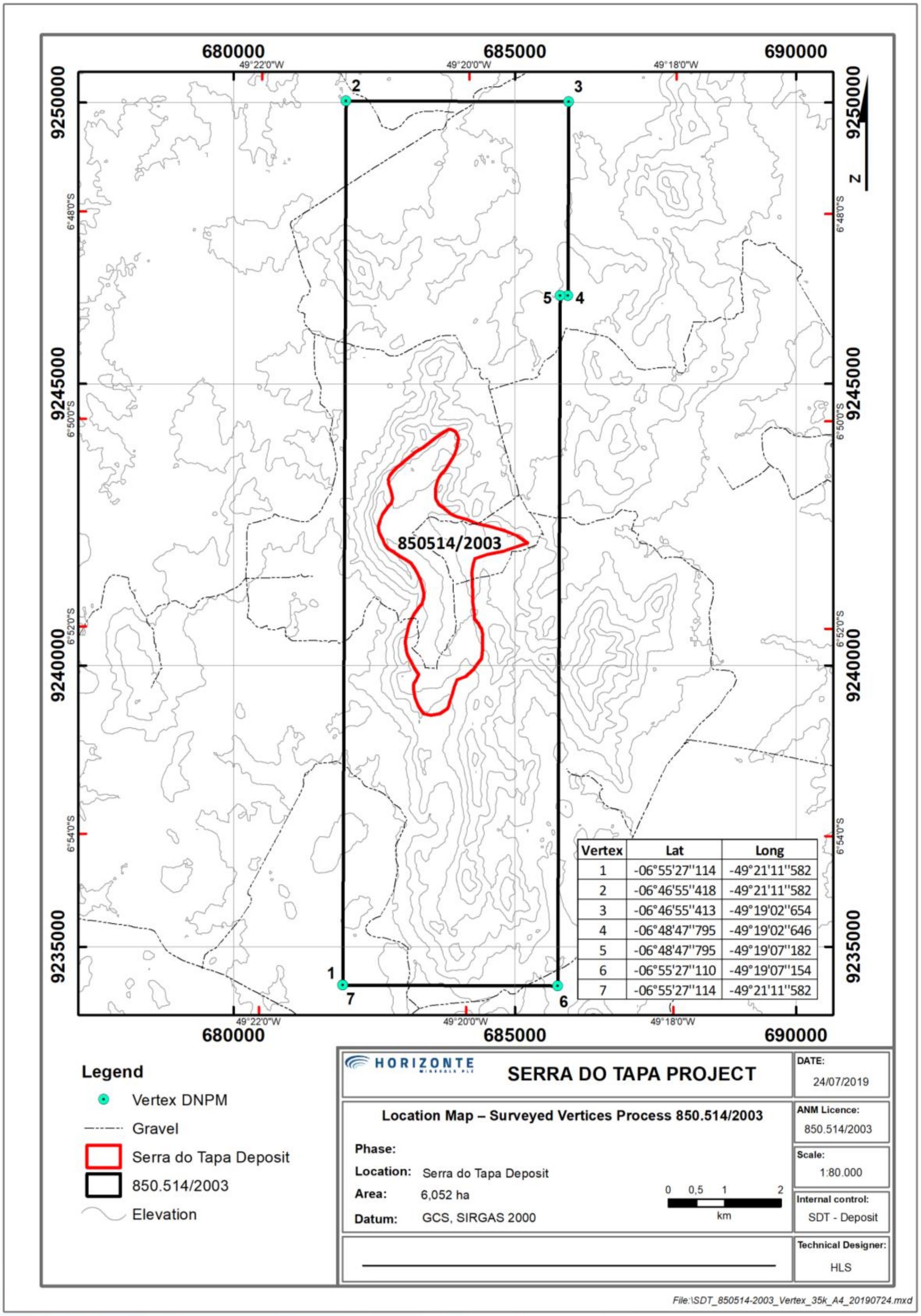
Table 4.1 SDT licence relevant to the Project

Process ID	Title holder	Area (ha)	Licence publication date	Deadline	Comment
850514/2003	Trias Brasil Mineração Ltda	6,052	08-Jan-2004	20/11/2017	Relatório Final de Pesquisa filed on 17/11/2017

The SDT licence surveyed vertices are shown in Figure 4.2.

HZM has not acquired any surface land rights for the Project, but the Company has agreements in place with the principal landowners for surface access rights covering the main deposits. Under the Brazilian Mining Law, there is a compulsory purchase mechanism for surface land rights over mining projects in the event that suitable terms cannot be agreed between the landowner and Company. HZM currently has good working relationships with the principal landowners.

Figure 4.2 SDT licence – surveyed vertices



Source: HZM, 2019c

4.3 Agreements and encumbrances

Agreements are in place with local farm landholders that allow access to land and conduct exploration with the minimum of disturbance, and progress to the construction licence stage.

4.4 Environmental obligations

At SDT there has been no significant increase in population since the original socio-environmental studies were conducted by Glencore-Xstrata.

The permit does not include any publicly registered legal reserves or federal/state forests.

The main economic activity is agriculture based.

An Environmental and Social Impact Assessment (EIA RIMA) will be conducted for the granting of the LP.

4.5 Permits

The permit summary for the SDT process is as follows:

- The final exploration report requesting process suspension (sobrestamento) for economic reasons was filed by Xstrata and accepted by ANM (DNPM at the time)
- At the end of the approved three-year process extension, Xstrata filed an update to the final exploration report requesting an additional extension for economic reasons, which was accepted by ANM (DNPM at the time).

The current permit status for SDT is summarised as follows:

- ANM is currently evaluating the HZM RFP update. HZM has requested report approval to move the project forward
- HZM is preparing the economic development plan known as the PAE
- The previous socio-environmental studies carried out at SDT will be useful to guide new social and environmental studies in the region.

The author knows of no other significant factors or risks that may affect access, title, or the right or ability of HZM to perform work on the property.

5 ACCESSIBILITY, CLIMATE, LOCAL RESOURCES, INFRASTRUCTURE AND PHYSIOGRAPHY

5.1 Topography, elevation and vegetation

The SDT permit area is characterised by undulating hill systems with elevated plateaus separated by shallow valleys. The SDT deposit is located on the elevated plateau shown in Figure 5.1 with typical low-lying pasture in the foreground. The highest elevation of the SDT area is 500 m ASL and the lowest elevation is approaching 280 m ASL.

The original vegetation is the equatorial latifoliated forest, with transitions to a tropical forest, dominated by low and medium size plants, and locally tall trees. At higher elevations Cerrado or savanna type wooded grassland with low to medium size plants is encountered, mixed with tropical forest. However, several decades ago, much of the lower lying area has been deforested, and is currently used for agriculture..

Figure 5.1 SDT topography and vegetation

Source: Osmond, JC, 2015

5.2 Access

Access to the SDT area is by aeroplane from:

- Belo Horizonte to Parauapebas (Pará), then 150KM by paved road on PA160 and PA155 to Sapucaia, then 70 km of unpaved road to the licence.
- Brasilia to Marabá (Pará), then by road from Marabá (by highway PA-155, 195 km of paved road to Sapucaia, then 70 km of unpaved road to the licence
- Brasilia to Araguaína (Tocantins), then 130 KM via highway TO-222, crossing the Araguaia River by ferry to Vila São José, then 40 km of non-paved road to the Property.

Apart from the high plateaus, the licence area is well served by dirt roads and numerous farm tracks easily accessed in a 4x4 vehicle.

Carajás, some 200 km to the northwest, is the railhead and point of loading for iron ore to be embarked at the deep-water port facilities of São Luis. The Araguaia River is being developed as a water transport route allowing barging between Marabá and the shipping port of Barcarena on the mouth of the Amazon.

5.3 Proximity to population centre and transport

Population density within the licence area is sparse and comprises mainly of isolated farms and homesteads. The closest town, São José do Araguaia currently has a population of approximately 3,500 (Instituto Brasileiro de Geografia e Estatística or IBGE, 2019), and minimal infrastructure. The municipality of Xinguara has a population of some 44,000 (IBGE, 2019) and is known as the capital of beef for southern Pará but agriculture, including cultivation of rice, corn, beans, watermelon, coconut, papaya and banana, remains the main industry of the region that drives its economy.

5.4 Climate

As described in AMEC (2008), the SDT property is in the Southeast region of Pará near the Araguaia River. The climate is characterised as equatorial super-humid, with average temperatures of 26°C (maximum of 32°C and minimum of 21°C) and high humidity (98% in the rainy season 52% in the dry season, and an average of 75%). A rainy season occurs from December through March, with rainfall between 1,500 mm and 2,000 mm per year.

5.5 Surface rights

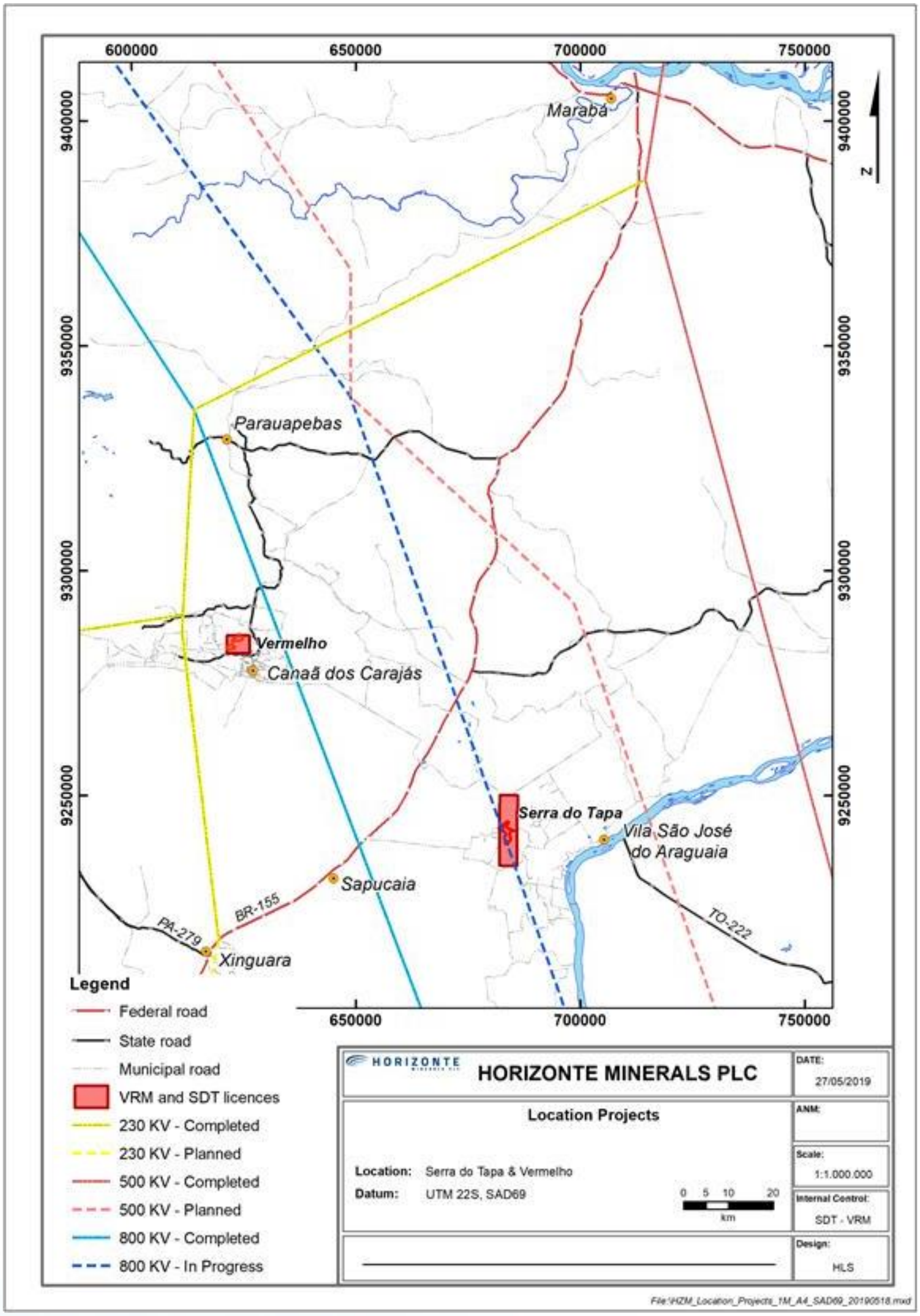
As of the date of this report, HZM has not acquired any surface land rights for the Project; however, HZM has agreements in place with all landowners for surface access rights covering the area with the deposits and any beneficiation plant site.

Under the Brazilian Mining Law, there is a compulsory purchase mechanism for surface land rights for mining projects in the event that suitable terms cannot be agreed between the landowner and Company. A Mining Servitude is required from ANM to implement this involuntary purchase mechanism. However, the Company intends to negotiate amicable agreements with all landowners, including families that reside on the land without any legal surface ownership rights. For that reason, a Land Access Strategy and Resettlement Action Plan were developed with guidelines to obtain surface rights in a fair and transparent manner. HZM has good working relationships with the principal landowners and villagers in the region.

5.6 Infrastructure

Infrastructure is shown in Figure 5.2. As described in AMEC (2008), the Carajás district is an established mining region with well-developed infrastructure in place, including rail, roads and hydro-electric power. The Carajás Mining District contains major iron ore, manganese, copper, and gold deposits as well as lead-zinc, nickel, bauxite and cassiterite. It is considered to be the most important mining district in the country and as such has seen a vast amount of investment and development since the 1970s.

Figure 5.2 Regional infrastructure



Source: HZM, 2019c

6 HISTORY

6.1 Previous exploration and development work

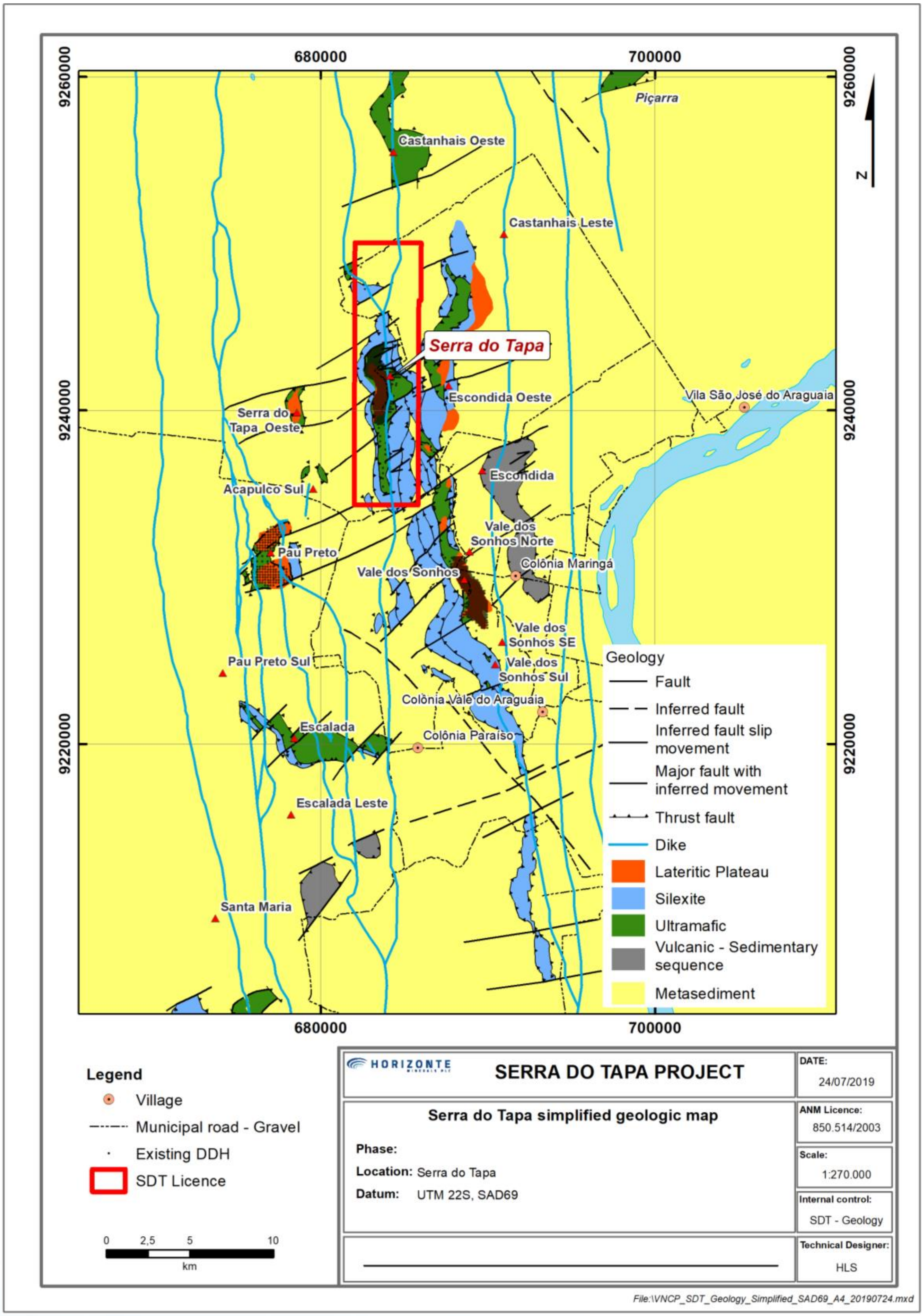
In 2003, Falconbridge Brazil Ltd (which became Xstrata Nickel in 2006) evaluated geological maps and geophysical images generated by Companhia de Pesquisa de Recursos Minerais (CPRM) in the 1970s. Based on this analysis, a series of areas were selected for reconnaissance work, including initially the SDT and Pau Preto (PP) locations before being expanded to include other surrounding areas. Snowden understands that the licence area had no history of mining or exploration prior to 2003.

Falconbridge-Xstrata Nickel continued exploration with geological mapping, geochemical sampling, photo interpretation, geophysics in several areas along the orogenic Araguaia belt. The SDT deposit was discovered in 2004 by Falconbridge-Xstrata near the prominent Cinzero ridge, which is now known as the SDT deposit.

The potential for low land areas to host significant nickel laterite mineralisation in the region was first is recognised after analysing a thick ferricrete cover that was previously interpreted on government maps as a sedimentary formation. Following recommendations to proceed with detailed exploration work, soil/termite mound and rock chip geochemical surveys were completed along seven east-west oriented lines, and one line oriented north-south with 50 m point spacing. This work yielded encouraging results with nickel soil anomalies up to 10,000 ppm that supported continued exploration. Subsequently, magnetometric and radiometric surveys confirmed the presence of mafic-ultramafic bodies in the area and indicated regional continuity along the north-south direction as shown in Figure 6.1.

As part of exploration activities of the mafic-ultramafic bodies, Xstrata Nickel completed drilling programs coupled with geological mapping. At SDT, a total of 48,845 m was drilled in 952 diamond drillholes (HQ for 63.5 mm nominal diameter) (Figure 6.1). A much smaller reverse circulation (RC) drilling program was completed in selected “test zones” to evaluate different drilling techniques in terms of penetration rate, recovery and general performance in relation to the various geological facies encountered..

Figure 6.1 Geological map



Source: HZM, 2018

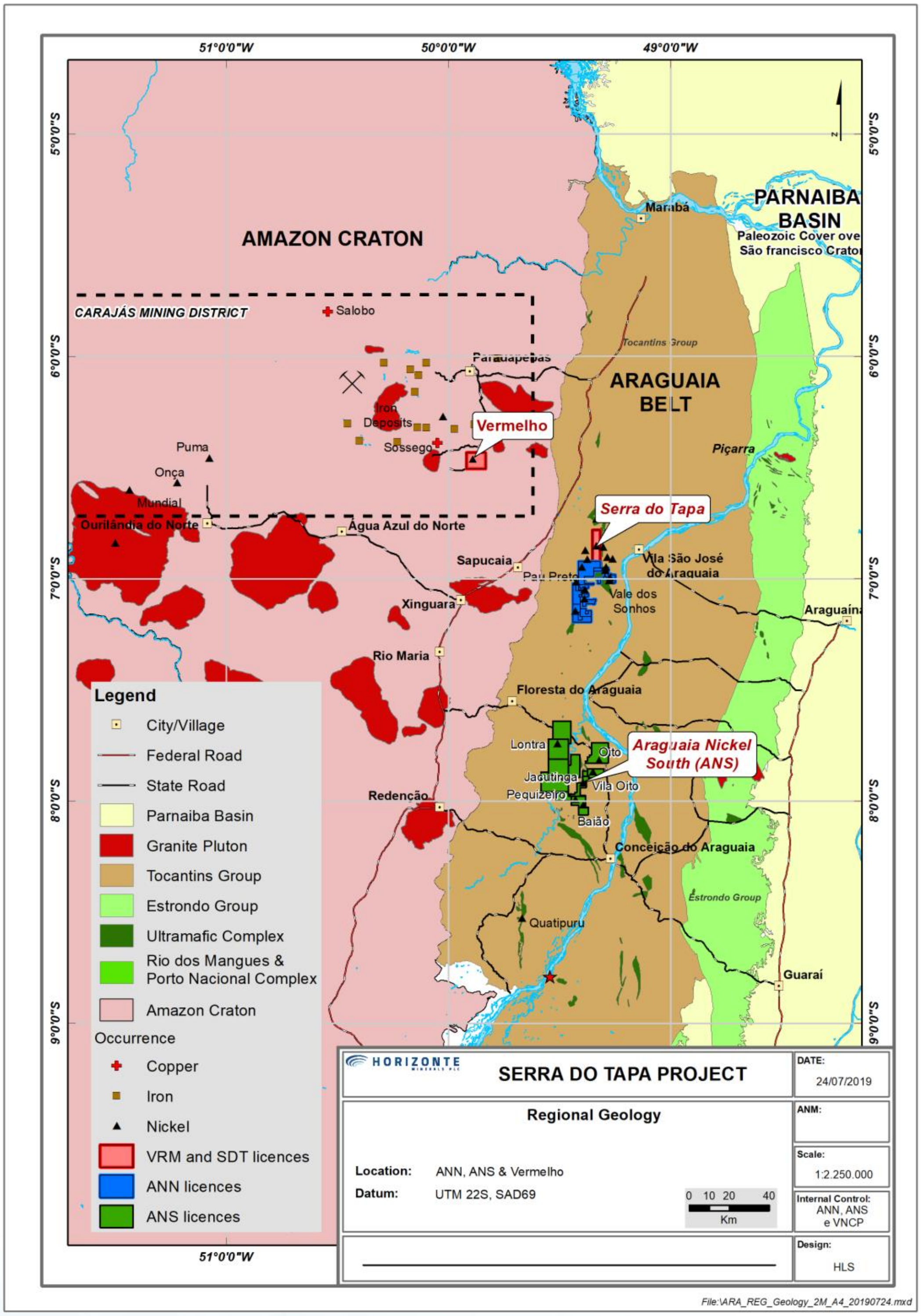
6.2 Historical Mineral Resource and Mineral Reserve estimates

A historical MRE was prepared by Xstrata in accordance with the CIM Definition Standards on Mineral Resources and Mineral Reserves (CIM, 2010) as published in the Glencore-Xstrata Resources and Reserves Report (31 December 2013) and compiled using geostatistical and/or classical methods, plus economic and mining parameters appropriate to each project. Glencore-Xstrata did not itemise Mineral Resources for individual licence areas and presented an overall total for all the deposits they had explored in the region including the SDT deposit. Any historical MRE has now been superseded with the current MRE reported in Section 14.

7 GEOLOGICAL SETTING AND MINERALISATION

The SDT area is presented in Figure 7.1 in relation to the other adjoining ANN licences.

Figure 7.1 Regional geologic setting



Source: HZM, 2019c

7.1 Regional geology

SDT lies within the Neoproterozoic Araguaia Fold Belt. This belt is a large north to south trending orogenic zone along the contact of the Amazon Craton to the west and the São Francisco Craton to the east (refer Figure 7.1). The Belt is 1,000 km long and 150 km wide and its evolution is considered to be contemporary with the Brazilian thermal event at the Neoproterozoic boundary.

The belt comprises metamorphosed and deformed marine-clastic sediments of the Tocantins Group and can be split into two halves based on the degree of metamorphism present. The more highly metamorphosed Estrondo Formation comprises the eastern half of the belt while the western half displaying lower levels of metamorphism is termed the Couto de Magalhães Formation.

The Estrondo Formation is dominated by greenschist to amphibolite facies grade metamorphosed sediments with occasional banded iron formations, carbonates and exposures of Archaean basement. Proterozoic granites intrude the eastern belt.

The Couto de Magalhães Formation contains weakly metamorphosed, marine pelites with local carbonate, iron-rich, and mafic to ultramafic bodies.

7.2 Deposit geology

The deposit geology has largely been interpreted from airborne geophysical survey data, soil sampling data, mapping and core drilling by previous owners of the tenements. Various types of metasediments cover the vast majority of the area. Large plateau areas, varying in size from a few hundred square metres to several square kilometres, and generally capped with a hard iron-rich duricrust that is occasionally silicified are frequently developed over mafic and ultramafic bodies. These bodies and numerous northwest-southeast to north-south trending lineaments have been identified from magnetic data and outcrop (refer to Figure 6-1). These bodies are often bounded by a siliceous breccia. Bodies of pillow lava and other volcanic material also exist. The area is cut by numerous mafic dykes

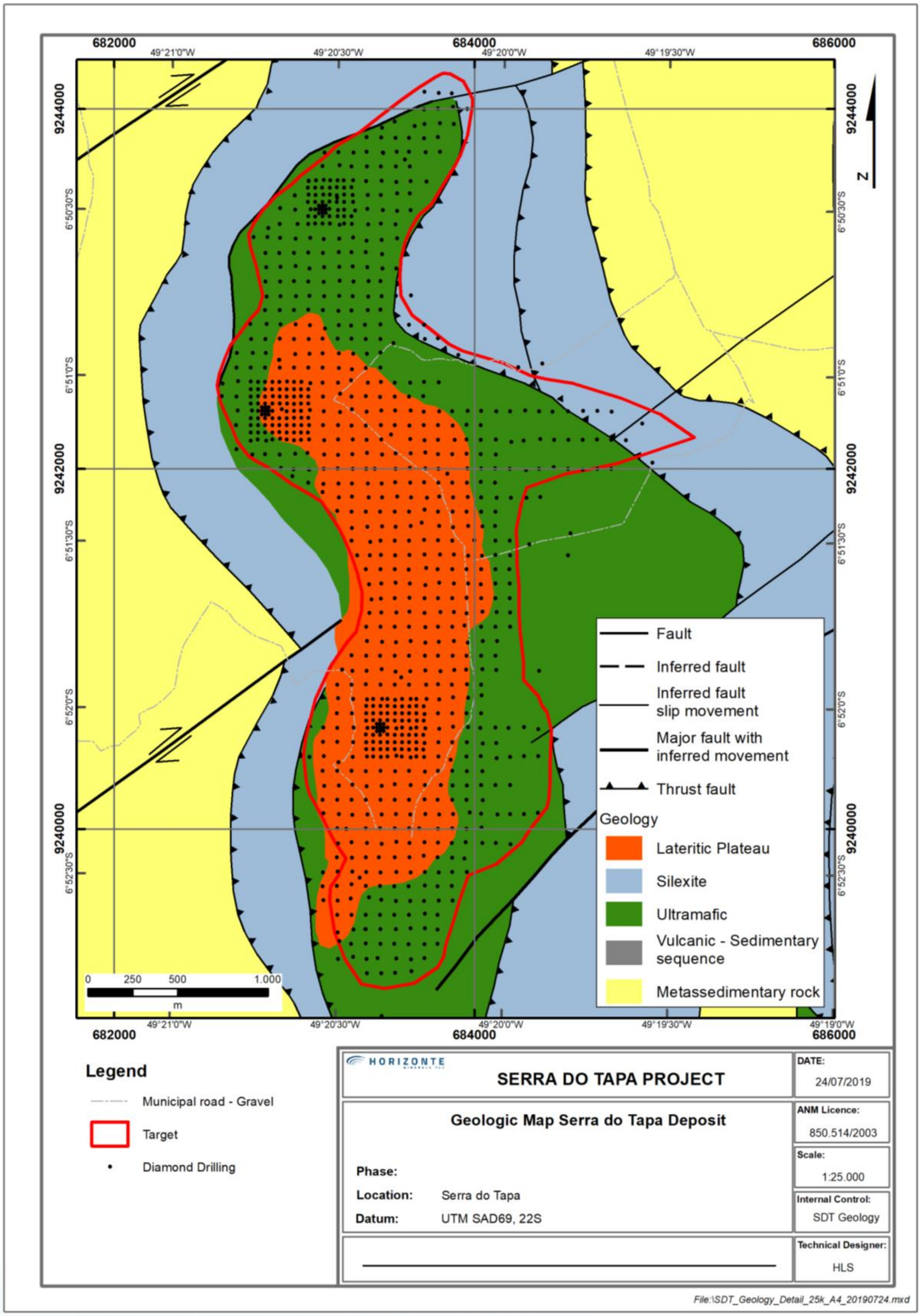
The SDT deposit has a sigmoidal shape with the long axis orientated in a north-south direction (Figure 7.2). The mineralised portion extends for some 5,000 m (north-south) and is up to 900 m in width. Figure 7.3 shows a schematic cross section of the local geology and the relationship between the SDT and the nearby VDS deposit, as well as the tectonic contact between main units.

Structural and geological mapping studies indicates that mapable structures have significantly increased the permeability of bedrock to groundwater movement, thereby promoting lateritic alteration and the development of nickel mineralisation.

The vertical extent of nickel mineralisation is significantly enhanced preferentially along steeply dipping fault structures within the Araguaia Belt. These faults form a complicated network as outlined by major lineament trends throughout the region. The primary orientation is N-S steeply dipping towards the East. Lineaments of WSW-ENE direction are frequent and appear younger than the N-S structures. Structures with a WSW-ENE direction have contributed to the development of the laterite profile.

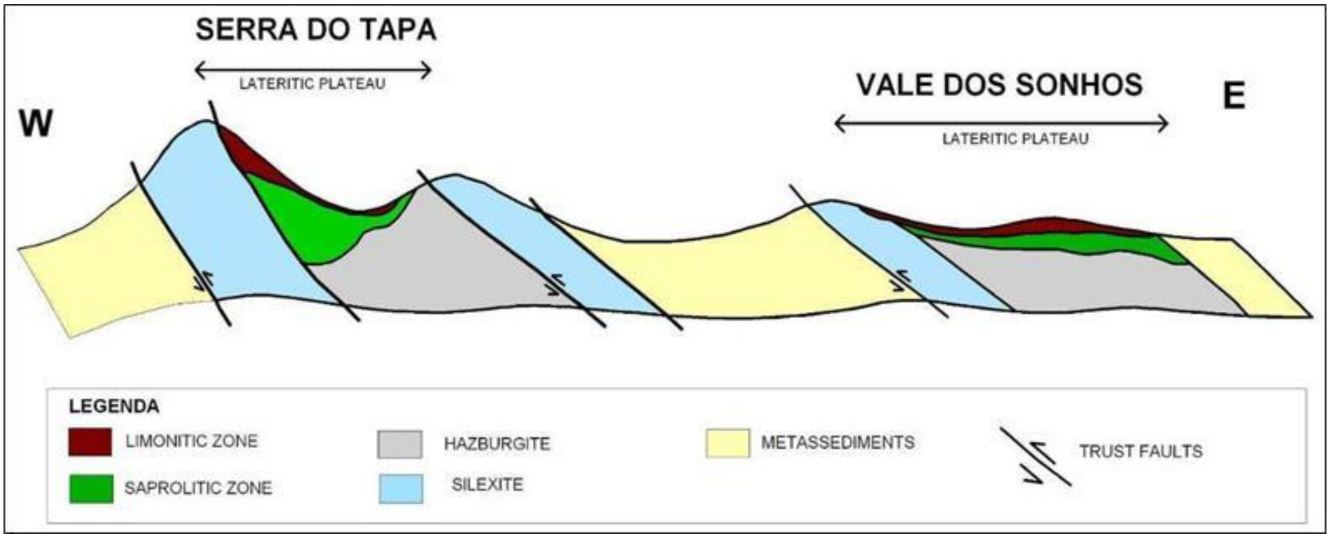
At SDT, the structural deformation was essential to the development of the weathering profile. Silexite members oriented N-S, which appear to be silicified thrust faults, are frequent and form basin edges within the ultramafic rock group. The chemical weathering within these individually formed basins has been very efficient, leading to the development of mineralised profiles reaching depths up to 100 m along the western edge. Structures with a WSW-ENE direction have contributed to the development of the laterite profile.

Figure 7.2 Geology map



Source: HZM, 2019c

Figure 7.3 Schematic vertical section of SDT and VDS deposits



Note: Not to scale
Source: AMEC, 2008

7.2.1 Physical criteria

A distinctive lateritic sequence is developed over ultramafic and mafic rocks. The sequence can be split into six main facies types: soil, ferricrete, limonite, transition, saprolite and fresh rock, as well as numerous sub-facies.

Lithological facies descriptions for SDT are described as follows:

Soil horizon

The soil layer is composed of organic and disaggregated material and is usually magnetic. The chemical composition of the layer is characterised by high iron and low nickel and magnesium oxide. The soil horizon has an average thickness of 0.2 m.

Ferricrete horizon

Dark brown to red in colour, the facies is formed by aggregated pisolites (iron oxy-hydroxides) that are often very hard and porous. The ferricrete horizon lies immediately below the soil horizon.

Limonite horizon

Below the soil and ferricrete horizons lies the limonite horizon which is made up of five distinct sub-facies – pisolite, red limonite, yellow limonite, red tapa and orange tapa:

- Pisolite sub-facies is dark brown to red in colour and comprises up to 70% loose pisolites (iron oxy-hydroxides). It also contains ferricrete fragments and may contain up to 30% of fine iron clay.
- Dark red-brown coloured, the red limonite sub-facies is plastic in texture and composed mainly of iron oxides and iron clays. White and black wisps and crusts of magnesium-manganese-cobalt hydroxides can also occur.
- Red tapa sub-facies is red-brown coloured with a plastic texture and contains less than 30% of smectitic clays or serpentine mixed in a matrix of iron oxides. The facies forms bands and laminations on a centimetre scale.

- Due to the dominance of goethite over hematite, the orange tapa sub-facies is orange-brown coloured. The facies contain less than 30% of smectitic clays or serpentine, is weakly plastic in texture and is frequently lightly banded.

Upper saprolite horizon

This is made up of four sub-facies – green tapa 1, green tapa 2, transitional 1 and transitional 2:

- Green tapa 1 is without the original rock texture and is green to dark green with minor brown clay bands of goethite, manganese oxy-hydroxides and silica veinlets. It is hard and composed of up to 90% smectitic clays.
- Green to brown in colour, the green tapa 2 sub-facies is soft and plastic in texture with 30% to 85% smectitic clay. Laminated with no protolith texture, it contains 6% to 60% iron oxy-hydroxides and up to 2% disseminated manganese oxy-hydroxides.
- Transitional 1 sub-facies is orange to brown soft and formed of millimetre to centimetre granules of green serpentine (up to 30%) immersed in an iron oxy-hydroxide matrix and also contains traces of magnesium oxide and talc. In the oxide phases, goethite is predominant over hematite.
- Transitional 2 sub-facies is green to brown, soft and poorly plastic in texture. It is formed from millimetre to centimetre granules of green serpentine (up to 30%) in a matrix of iron oxide.

Lower saprolite

This consists of two sub-facies – green tapa 3 and saprock:

- The green tapa 3 is light green in colour, poorly plastic and contains up to 70% of serpentine granules with 5% to 10% talc. Traces of chlorite and magnesium oxide are also present.
- Consisting dominantly of serpentine, the saprock sub-facies also has minor amounts of smectitic clay and talc. It is light green and friable with original rock textures preserved and contains abundant amorphous silica and iron oxy-hydroxides.

Silicified saprolite and fault zone

There are three sub-facies for this unit – talc, silicified saprolite and silcrete:

- Talc is white to purple, soapy, soft but not plastic in texture and foliated in fault zones. It is very talc rich with less than 5% of serpentine, brown clay, free silica and manganese oxy-hydroxides.
- Pink to grey-green and hard, the silicified saprolite sub-facies is spatially associated with silcrete or silexite. An increase of silicification is associated with an increase in hardness and change in colour to pink.

Bedrock facies

The bedrock facies are made up of three sub-facies – weathered harzburgite, harzburgite and silexite:

- Weathered harzburgite consists of grey-green friable weathered rock with blocks of unweathered hard rock, orange filled fractures and manganese oxy-hydroxides.
- Harzburgite is hard, grey-green and is formed of millimetre to centimetre pseudomorphic crystals of bastite resulting from orthopyroxene weathering in a dark green to grey-green mas of serpentine. Usually present are veinlets and fractures filled by light green serpentine, talc and small amounts of carbonate.
- Silexite sub-facies is a purple, brown or red competent silica rich breccia of green magnetic material with commonly with silica veinlets.

Other facies

There are three other sub-facies recognised at SDT – gabbronorite/weathered gabbronorite, mafic saprolite and metasediment:

- Gabbronorite is brown with an ophitic texture
- Weathered gabbronorite becomes yellow and friable with distinct white plagioclase
- Mafic saprolite sub-facies is yellow-brown and friable with poor plasticity and has relict white plagioclase and an ophitic texture
- Metasediments are light yellow to grey, soft with weak foliation and are often absent from the geological column.

Table 7.1 below provides a summary of the lithological facies for SDT showing the logging code and description.

Table 7.1 Summary of lithological facies

Facies	Description	Code
Group material: Limonite		
Soil coverage	Composed of disaggregated material, usually magnetic and rich in organic matter, with 20 cm average thickness.	SOIL
Ferricrete	Dark brown to red, formed by aggregated pisolites (Fe-oxy/hydroxides). The facies is very hard and often porous.	FRC
Pisolite	Dark-brown to red, up to 70% of loose pisolites (Fe-oxy/hydroxides disaggregated nodules), contains ferricrete fragments. May contain up to 30% fine Fe-clay.	PIS
Red limonite	Dark red-brown coloured, plastic and texturally amorphous. Composed mainly by Fe-oxides and Fe-clays, white and black wisps and crusts of Mg-Mn-Co oxy-hydroxides can also occur.	RL
Yellow limonite	Yellow-orange-ochre to dark-brown with ochre spots, loose or compact and plastic often with sub-horizontal lamination and particles or veinlets of silica and Mn-oxy/hydroxides (wad). Composed mainly by Fe-oxy/hydroxides and Fe-clays. Without smectite-clay or serpentine.	YL
Red tapa	Red-brown coloured, plastic with less than 30% of smectite-clays or serpentine mixed in a Fe-oxides matrix, that forms bands and laminations at centimetric scale.	RT
Orange tapa	Orange-brown coloured from the dominance of goethite over hematite in the oxide phases. The facies contain less than 30% of smectite-clays or serpentine, is weakly plastic and is frequently lightly banded.	OT
Group material: Upper Saprolite		
Green tapa 1	Green to dark green, hard and friable to cohesive and compact with up to 90% of smectite-clays, without original rock texture and minor brown clay bands, goethite, Mn-oxy/hydroxide and silica veinlets.	GT-1
Green tapa 2	Green to brown, soft but compact/cohesive and plastic with 30% to 85% of smectite-clay. Laminated with no protolith texture, 6-60% Fe-oxy/hydroxide layers. Up to 2% disseminated Mn-oxy/hydroxide.	GT-2
Transitional 1	Orange to brown, soft, cohesive poorly plastic, incipient granular rock texture. Formed of millimetric to centimetric granules of green serpentine (up to 30%) immersed in a Fe-oxy/hydroxide matrix. Contains traces of Mn-oxide and talc. Goethite predominate over hematite in the oxide phases.	TZ-1
Transitional 2	Light green to brown, soft, cohesive poorly plastic, incipient granular rock texture. Formed of millimetric to centimetric granules of green serpentine (up to 30%) immersed in a Fe-oxide matrix.	TZ-2
Group material: Lower Saprolite		
Green tapa 3	Light green, compact, friable, poorly plastic, up to 70% of serpentine granules with 5% to 10% talc associated and traces of chlorite and Mn oxide.	GT-3
Saprock	Light green and friable with rock texture preserved. Consist dominantly of serpentine with minor amount of smectite-clay and talc. Fractures contain abundant amorphous silica and Fe-	SAPR

Facies	Description	Code
	oxy/hydroxides.	
Group material: Silicified Saprolite and Fault Zone		
Talc	White to purple, soapy, soft and compact but not plastic. Very talc rich with less than 5% of serpentine, brown clay, free silica, and Mn-oxy/hydroxides, foliated in fault zones.	TLC
Silicifed saprolite	Pink-grey-green, hard, spatially associated with silcrete or silexite. Saprolite material that has been silicified, giving a slight pinkish colour and increasing the hardness.	SSAP
Silcrete	Light-brown to dark-red, hard, competent, gritty, near 100% amorphous silica, occurs at the top or at mid profile. Contacts are sharp and the silcrete is generally thin.	SIL
Group material: Bedrock Facies		
Weathered harzburgite	Grey-green, mixed friable weathered rock with blocks of unweathered hard rock. Orange-filled fractures and Mn-oxyhydroxide. Weathering of gabbros provides a yellowish-brown material with incipient ophitic texture (white plagioclase).	WHZ
Harzburgite	Grey-green, hard, formed of pseudomorphic (millimetric to centimetric) crystals of bastite resulting from orthopyroxene weathering, in a dark green to grey-green mass of serpentine, with fine to medium granulation and moderate to strong magnetism. Usually present are veinlets and fractures filled by light green serpentine, talc and, in smaller amount, carbonate.	HZ
Silexite	Purple, wind, brown, red; hard and competent, silica-rich with brecciated texture and dots of green magnetic material. Silica veinlets and boxwork texture are common. Becomes loose and friable near contact.	SLX
Group material: Other Facies		
Gabbronorite, weathered gabbronorite	Brown with ophitic texture. Weathered gabbronorite becomes yellow and friable with distinct white plagioclase.	GN, WGN
Mafic saprolite	Yellow-brown, friable, poorly plastic, competent saprolite with relict white plagioclase and ophitic texture.	MSAP
Metasediment	Light-yellow to grey, soft, plastic, foliation weak and often absent.	MSD

7.2.2 Chemical criteria

The facies are grouped into geological horizons according to major elemental chemistry. Geological horizons are differentiated by iron, magnesium oxide, silica, alumina and nickel grades. A set of rules based on chemistry allows classification of specific mineralised horizons designated 100 (Limonite), 200 (Transition) and 300 (Saprolite).

7.3 Mineralisation

Mineralogical evaluation was undertaken by SGS Lakefield, Canada using quantitative evaluation of materials by scanning electron microscopy (QEMSCAN), electron probe microanalysis (EPMA) and X-ray diffraction (XRD) methods of analysis. The objective of the program was to provide basic mineralogical information on a sized composite.

The mineralogy of the composite sample (composed of samples from both the SDT deposit as well as the nearby VDS deposit) is dominated by serpentines, clays (15%) associated with the alteration of serpentine, iron-montmorillonites, chlorites, iron oxides and minor amounts of asbolane, quartz and talc. Higher oxide content in VDS composite suggests that weathered facies (limonitic and transitional) are more dominant.

With the exception of quartz and gibbsite (trace amounts), all other species identified in this study carry nickel. Sixteen nickel-bearing minerals were quantified by EPMA. The richest nickel-bearing species are nickel-serpentine and two variations of asbolane; low manganese asbolane and low nickel-cobalt asbolane. These three species carry an average of 4.8%, 12.0% and 3.5% nickel. However, there is a relatively minor amount of asbolane present. The majority of nickel within VDS is hosted by nickel-serpentine, chlorite, iron-montmorillonite, antigorite and oxide species.

Nickel grade drops slightly in very coarse size fractions due to an increase in antigorite content, and a corresponding drop in other species such as chlorite and iron-montmorillonite. Antigorite carries an average of 0.95% Ni, whereas the chlorites and iron-montmorillonites have nickel grades between 1.4% Ni and 1.74% Ni.

The distribution and textures associated with nickel deportment suggest that upgrading will be difficult. This conclusion is based on the fact that many mineral species contain nickel; they are observed throughout the size distribution and vein and rimming textures are extremely rare.

The transition 2 sample, submitted for upgrading evaluation, is lower grade than the composite samples analysed due to lower abundance of nickel-serpentine. The remaining mineral species contain low levels of nickel. In the coarse saprolitic samples, removal of quartz may improve the overall grade. However, some samples show an association of asbolane with quartz. The removal of quartz in any upgrading program will also risk the loss of nickel and cobalt within asbolane (which is locked with quartz).

Examples of drillhole cross-sections are provided in Figure 7.4 to Figure 7.6.

Figure 7.4 ANN SDT cross section 9240800

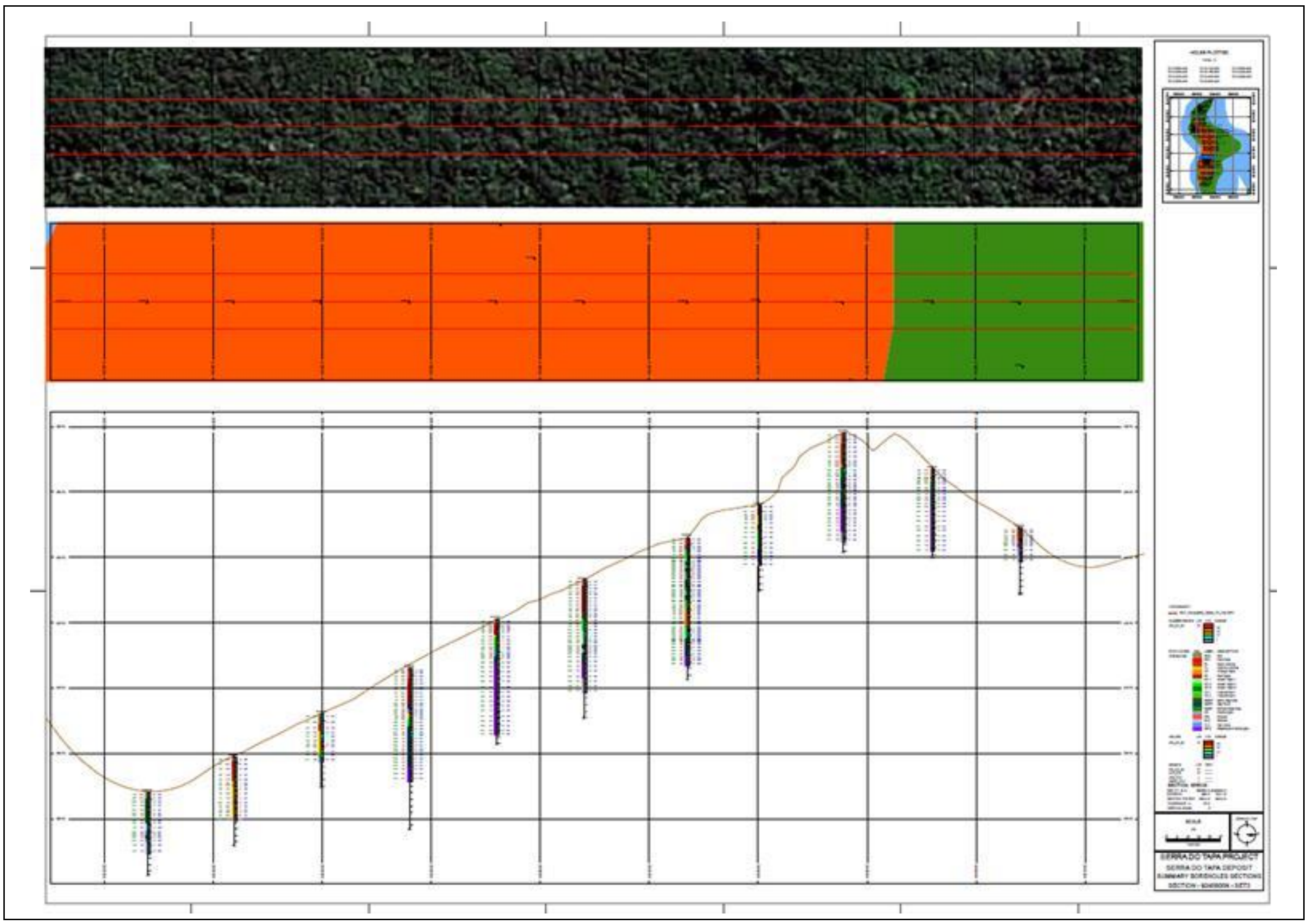


Figure 7.5 ANN SDT cross section 9242000 (Part 1)

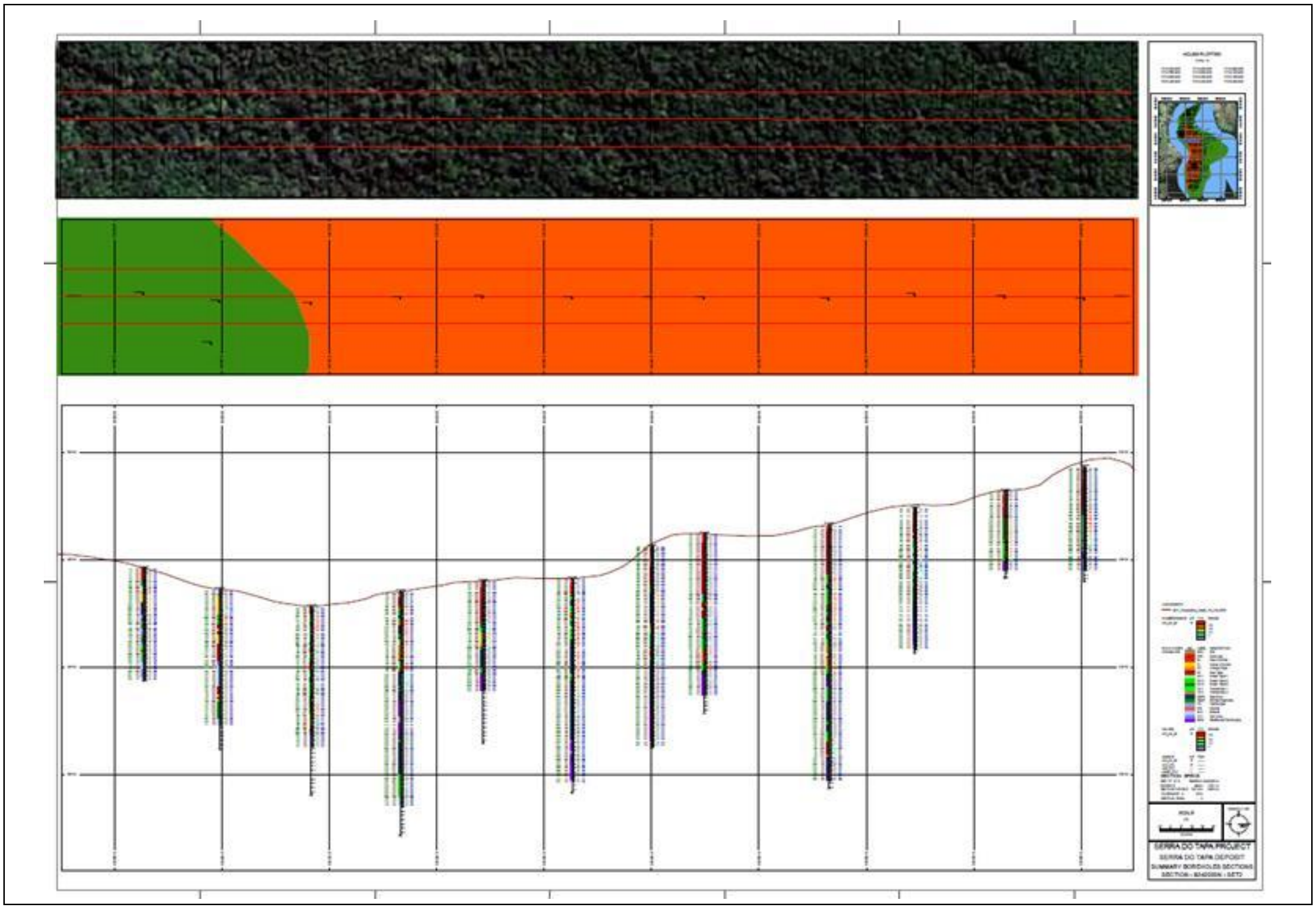
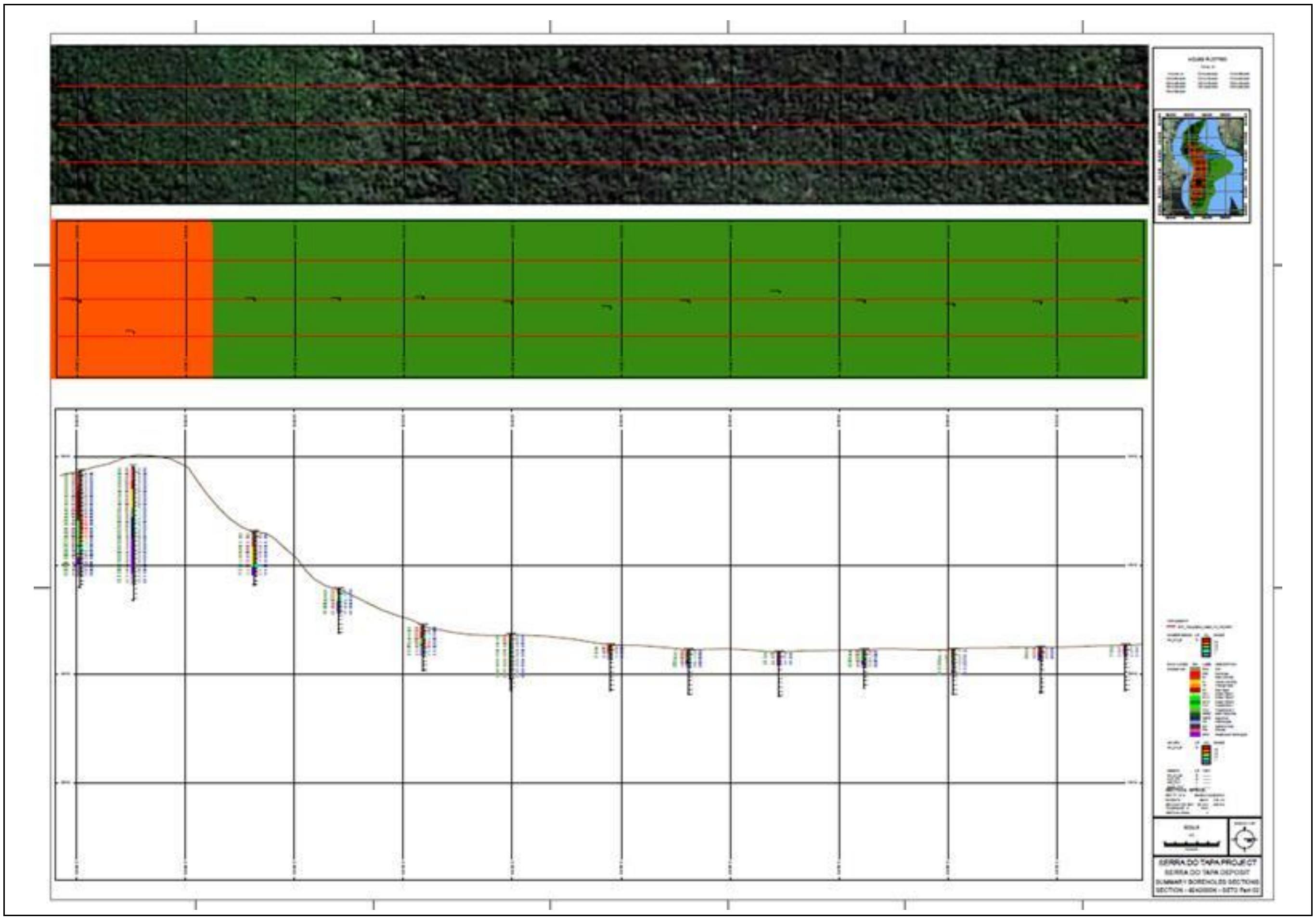


Figure 7.6 ANN SDT cross section 9242000 (Part 2)



8 DEPOSIT TYPES

The target mineralisation is nickel. The SDT deposit is characteristic of typical nickel laterite deposits formed in a seasonally wet tropical climate, on weathered and partially serpentinised ultramafic rocks. Features of nickel laterites include:

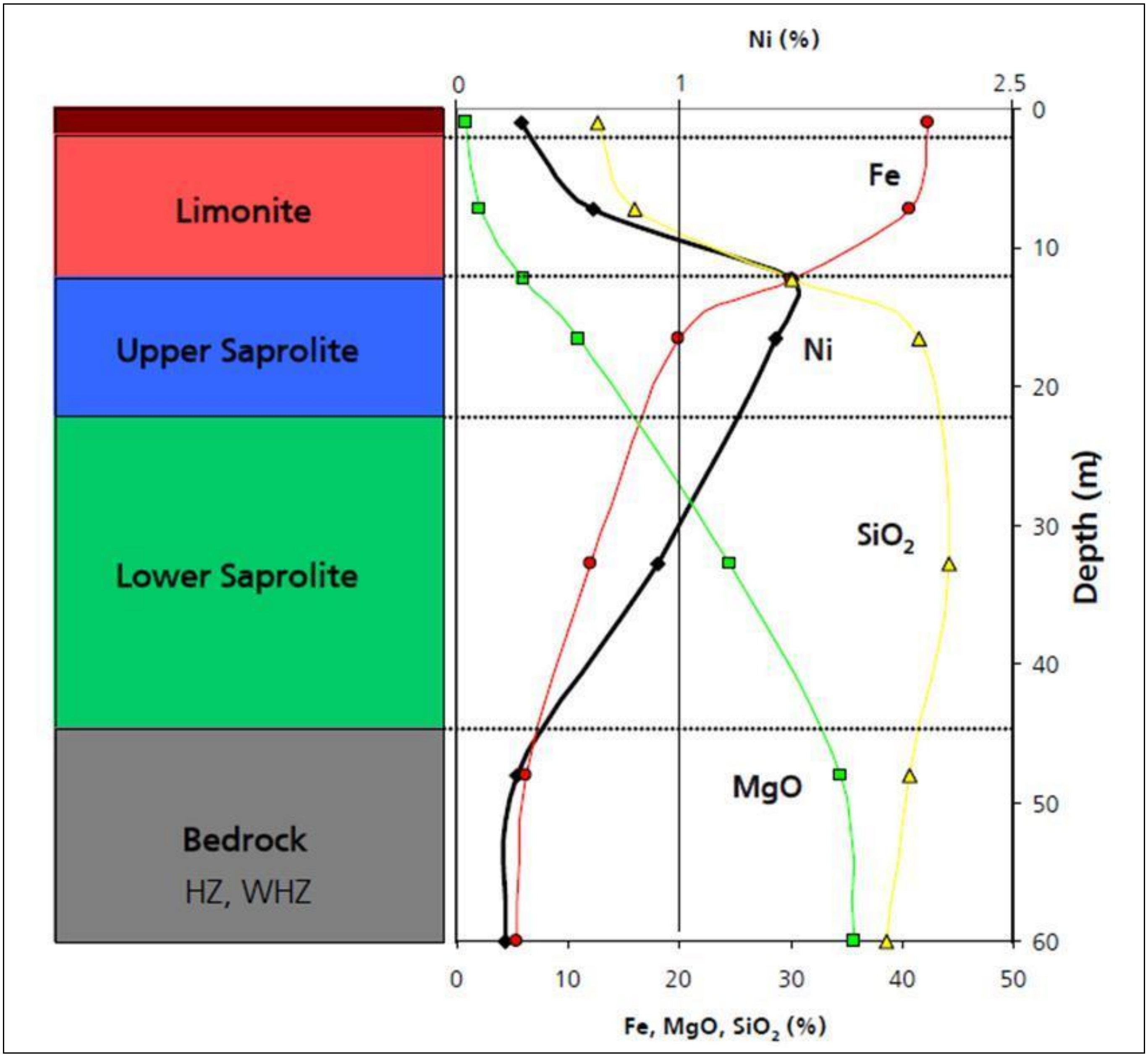
- The nickel is derived from altered olivine, pyroxene and serpentine that constitute the bulk of tectonically emplaced ultramafic oceanic crust and upper mantle rocks.
- Lateritisation of serpentinised peridotite bodies occurred during the Tertiary period and the residual products have been preserved as laterite profiles over plateaus/amphitheatres, elevated terraces and ridges/spurs.
- The process of formation starts with hydration, oxidation, and hydrolysis, within the zone of oxidation, of the minerals comprising the ultramafic protore.
- The warm/hot climate and the circulation of meteoric water (the pH being neutral to acid and the Eh being neutral to oxidant) are essential to this process. Silicates are in part dissolved, and the soluble substances are carried out of the system.
- This process results in the concentration of nickel in the regolith in hydrated silicate minerals and hydrated iron oxides; nickel and cobalt also concentrate in manganese oxides. The regolith hosting nickel laterite deposits is typically 10 m to 50 m thick, but can exceed 100 m.
- Concentration of the nickel by leaching from the limonite zone and enrichment in the underlying saprolite zones is also common. Leaching of magnesium ± silicon causes nickel and iron to become relatively concentrated in the limonite zone. Nickel is released by re-crystallisation and dehydration of iron oxy-hydrides and is slowly leached downwards through the profile, both vertically and laterally, re-precipitating at the base with silicon and magnesium to form an absolute concentration within the saprolite (Figure 8.1).
- The degree of the nickel concentration and the detailed type of regolith profile developed is determined by several factors including climate, geomorphology, drainage, lithology composition, and structures in the parent rock, acting over time.
- A typical laterite profile contains two distinct horizons, limonite (oxide) and saprolite (silicate). The transition between these two horizons can be thick.

Exploration criteria is summarised from Brand *et al* (1996) as follows:

- Geological massifs with olivine-rich lithologies and their metamorphic derivatives, large enough to host nickel laterite deposits that will support low-cost, high-tonnage, open-cut mining operations, must initially be identified.
- Airborne magnetic surveys, regional mapping and known occurrences of lateritic nickel are useful to identify likely targets.
- Later, detailed geological and geophysical surveys may be needed to delineate olivine-rich lithologies and faulting that may represent sites for shallow, high-grade manganese-cobalt-nickel and garnierite mineralisation.
- Regolith landform mapping and reconnaissance drilling can be used to determine the nature and distribution of the regolith (i.e. whether in-situ, concealed or stripped) and those zones that host nickel enrichments.
- Regional drilling and possibly soil sampling of in-situ regolith can be used to identify nickel halos (greater than 0.5% Ni) and target the most prospective parts of a weathered ultramafic sequence.
- Follow-up drilling to delineate nickel-enriched zones will, in association with geochemistry and mineralogy, provide valuable information on the geological and metallurgical characteristics of any

nickel laterite. For metallurgical purposes, it is useful to maintain a consistent element suite when analysing drill samples (Ni, Co, Mn, Cr, Mg, Fe, Si, Al and ignition loss).

Figure 8.1 Chemical trends in schematic nickel laterite profile



Source: AMEC, 2008

The SDT laterite is mineralogically similar to the limonitic laterites of Western Australia and, like the Australian ores, are amenable to pressure acid leaching. Another possible treatment route of the higher grade saprolite ores is the Rotary Kiln Electric Furnace (RKEF) process as proposed for HZM's ANP.

9 EXPLORATION

HZM has not conducted any exploration work on the SDT licence. All exploration work on the licence was completed prior to ownership by HZM and is described in Section 6.

10 DRILLING

HZM has not conducted any drilling work on the SDT licence and all drilling work was completed prior to HZM ownership.

10.1 Diamond drilling

Drillholes on the SDT deposit were located by Falconbridge-Xstrata within a geological outline defined by the thick development of lateritic profile on the Cinzero plateau. Diamond drilling (DD) was selected as the most appropriate drilling method by Xstrata Nickel (2004 to 2007), although several reverse circulation ("RC") drillholes were completed for comparison. At SDT, the discovery hole FCZ-04-07 was completed in October 2004 and intersected 20.0 m of laterite with an average grade of 1.5% Ni.

Geoserv-Boart Longyear (Geoserv) was the main drilling contractor, although Servitec Ltda (Servitec) and Rede Ltda (Rede) have also been used in the drilling campaigns at SDT (Table 10.1). The company Contemat Ltda (Contemat) was also used in 2005. Xstrata maintained permanent supervision of the drilling operations throughout.

Table 10.1 Drilling contractor summary for SDT

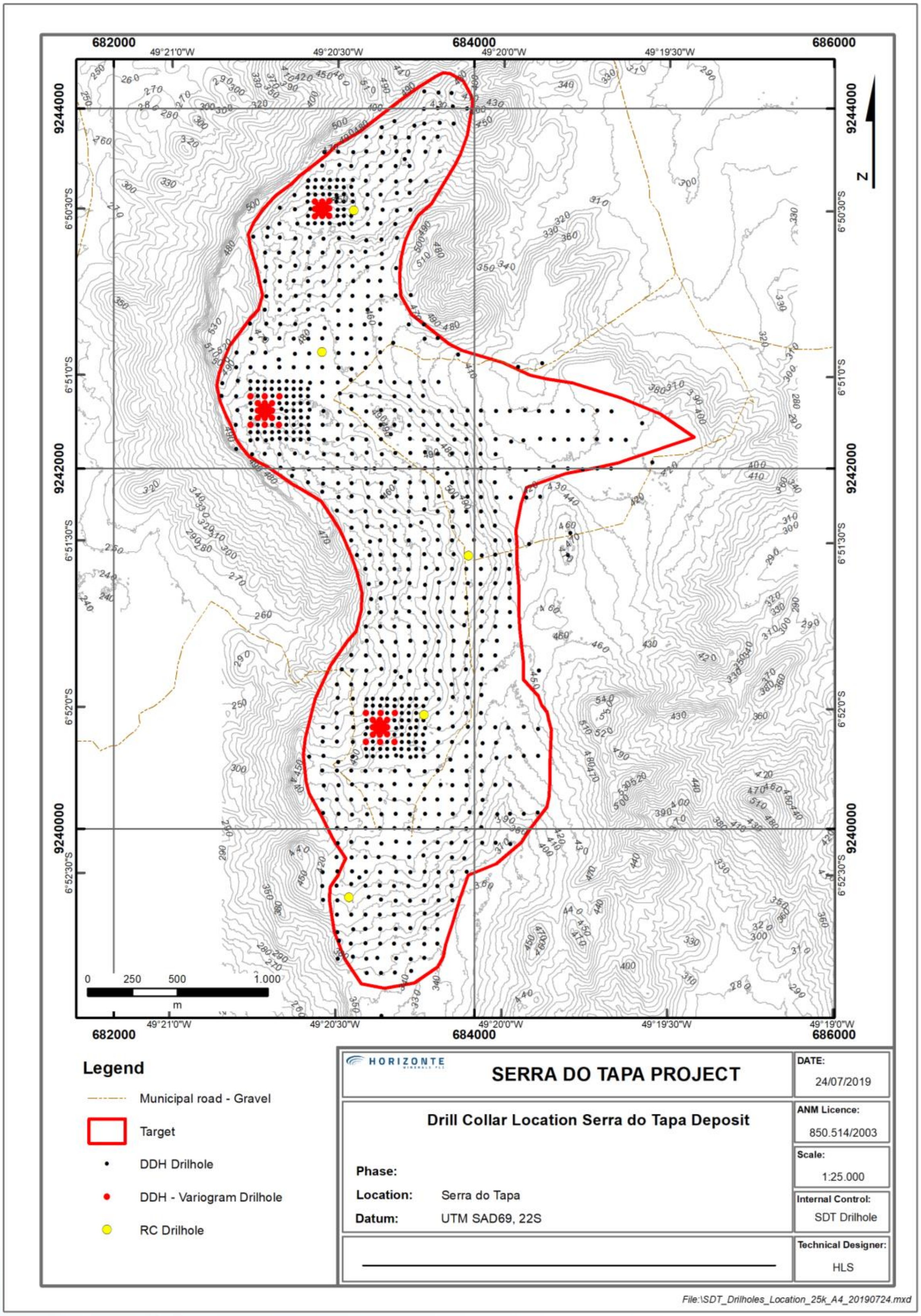
Drilling company	No. of holes	Metres drilled
Geoserv	750	38,415
Servitec	122	7,539
Rede	1	102
Contemat	79	2,739
Total	**952**	**48,845**

The program started with a 320 m x 320 m spaced pattern, subsequently followed with complete coverage on an 80 m x 80 m grid with small areas of closer spaced drilling completed to evaluate short-scale variability. In the last stage of drilling three areas of 40 m x 40 m drilling and closer were completed. A total of 952 DD holes were completed for 48,845 m (42,092 samples) (Figure 10.1). No drilling has been undertaken since this period.

The DD diameter used was HQ (63.5 mm nominal diameter) and all holes were vertical. Core runs were consistently 1.6 m, although shorter runs were encountered for zones with low recovery. Drill cores were removed from the core barrel by water pressure to an angular channel-shaped steel stand. Core recovery was measured by drill run immediately after being removed from the core barrel and before being placed in 1.0 m long wooden core boxes (wrapped in thick polyethylene sheets to maintain the original moisture). Drilling was stopped only after the hole has encountered at least 5.0 m of fresh rock. The drilling company conducted down-hole surveying on drillholes exceeding 100 m depth using the EZ-shot method taking readings every 30 m (note that all holes were vertical).

Core recovery is highly dependent on rock facies. Hard siliceous facies usually yield low recoveries (as low as 64%), but the mineralised facies (e.g. GT-1, GT2, TZ-1 and TZ-2) typically show excellent recoveries (93% to 100%). Each box was identified with the drillhole number and the box sequential number. Core boxes were collected each day and transported by truck to the camp site, always with nailed wooden covers. Core boxes did not remain on the drill site after shift change or after demobilisation from the drill platform.

Figure 10.1 Drill collar locations



Source: HZM, 2019

10.2 Reverse circulation drilling

A RC drilling program was undertaken to evaluate different drilling techniques in-terms of penetration rate, recovery and general performance in relation to the various geological facies encountered. The RC holes were drilled at a distance of typically less than 10.0 m from previous DD (references holes) that were used to predict the composition of the material collected.

10.3 Survey grids and collar locations

All drillhole collars were located based on the IBGE base datum SAD69. Surveyors used a total station to mark the location of proposed drillholes in the field. Upon completion of drilling, each hole was re-surveyed to record the actual drilled location. Drillhole collars are marked in the field using concrete or metal monuments labelled with the drill identification (“ID”). All the drillhole locations are shown on Figure 10.1.

10.4 Core logging procedures

Xstrata followed a set of written procedures for logging and sampling at SDT.

Information recorded included hole ID, collar coordinates, type of collar orientation (azimuth, dip), drilling company, start date, end date and the name of the geologist responsible for logging. Logging of core was completed on logging sheets where information regarding sampling intervals, sample numbers, main and secondary facies (in coded form) and mineralisation style were recorded.

At the core logging facility, core was inspected and rocky saprolite and fresh rock intersections were cut into equal halves using a diamond saw. Limonite and earthy saprolite core was split into equal halves using a blade. Core was then laid out in order on tables and logged with respect to the metreage markers inserted by the drillers.

10.5 Geotechnical

No geotechnical work has been completed at SDT.

10.6 Qualified Person’s comment on drilling procedures

It is the Qualified Person’s opinion that the procedures described by Falconbridge-Xstrata for core drilling were thorough and provided the appropriate level and quality of information required to interpret the laterite profile and to form the basis for MREs. There is no apparent drilling or recovery factor known to the QP that would materially impact the accuracy and reliability of the diamond core drilling results.

11 SAMPLE PREPARATION, ANALYSES, AND SECURITY

HZM has not conducted any sample preparation, analyses and security undertakings on the SDT licence. All sample preparation and analyses on the licences were completed prior to ownership by HZM.

The following sections describe the preparation and analysis of samples and security of samples as carried out by Xstrata for the SDT deposit.

11.1 Sample preparation methods and Quality Control measures

Between 2004 and the end of 2005, core samples were submitted to SGS facilities in Parauapebas for preparation and dispatch to SGS Geosol for analysis. In January 2006, Xstrata built and commenced operation of a sample preparation facility at the field office near Vila São José with SGS Geosol providing direct supervision of sample preparation and dispatch for analysis.

11.2 Sample splitting

At the core logging facility core was inspected, rocky saprolite and fresh rock intersections were cut into equal halves using a diamond saw. Limonite and earthy saprolite core was split into equal halves using a blade.

Sampling intervals had a nominal length of 1 m, and as a rule respected major facies contacts. Sample lengths ranged from 0.3 m to 1.5 m with two-thirds of the samples having lengths between 0.8 m and 1.2 m. Longer samples were allowed only in low-recovery intervals or in waste rock. Samples were taken from the right-hand side of the core with sample intervals marked on plastic sheets for wrapping the cores.

After logging and sampling, trained personnel placed samples into plastic bags. The sample number was written on the outside of the bag, a thick paper tag with the sample number was inserted into the bag and the bag was tightly secured with a plastic strap. These samples were then placed into larger plastic bags, up to 50 kg, for transportation to the sample preparation facility at the main Xstrata camp near Vila São José. Chain of Custody forms were filled in when samples changed custody. Core boxes, with the remaining core, were transferred on a monthly basis to the permanent storage facility, also located at the main camp.

11.3 Security measures

According to written procedures, sample and data collection were handled by Xstrata personnel on site. Drill core was wrapped in thick polyethylene sheets to maintain the original moisture then placed in wooden core boxes and nailed shut, reverse cycle samples were bagged and tied at the drill site ensuring every care was taken to eliminate contamination and security breaches in the transfer of core and reverse cycle samples from drill site to the processing facility. Core boxes (and reverse cycle samples) were collected daily, at the end of each shift by Xstrata personnel and delivered to the Base Camp for subsequent logging and sampling.

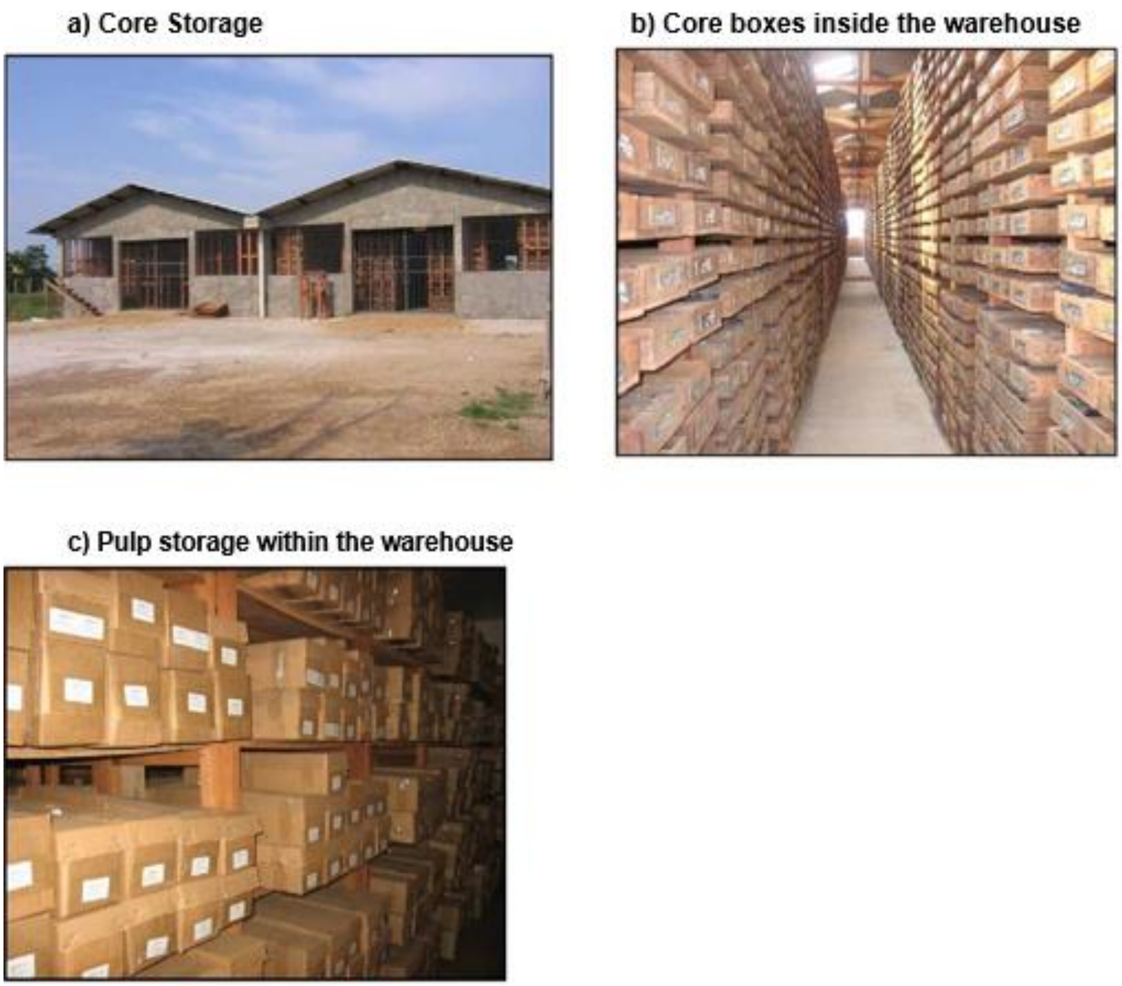
According to written procedures, drill core logging was initially recorded by hand on paper log-sheets before being transferred to electronic format and the project database. Both data records remained available for validation.

Prepared samples were transported in a company truck to the SGS Geosol laboratory in Parauapebas where custody of the samples was handed over to SGS. Dispatch sheets were used and signed to confirm dispatch and receipt of sample batches. SGS Geosol dispatched the samples to Belo Horizonte by TAM cargo from Marabá. Upon arrival at SGS Geosol in Belo Horizonte, batch data were entered into the laboratory information management system (LIMS). Analytical results were received from SGS in digital format via email as well as a hardcopy that had been signed.

All half-core splits from the logging tables were sent to the Base Camp in Vila São José (Figure 11.1). They are stored in order by hole/box number in fabricated core rack modules. All drillholes were individually catalogued and their locations recorded in a logbook.

Reject samples were placed in bags then put into larger plastic boxes and stored at site. Pulp sample splits for assaying were initially kept at the assaying facility of SGS in Belo Horizonte, Brazil. The remaining pulp samples were bagged and stored in the warehouse in Vila São José.

Figure 11.1 Sample warehouse at Vila São José base camp



Source: HZM, 2015

11.4 Bulk density measurements

Bulk density measurements were determined using the water displacement method, standard wet weight in air and in water, and dry weight method. Core was wrapped in plastic film to prevent water penetration into the core. Density was calculated using Archimedes' principle. Bulk density testing was completed as soon as possible after the core arrived in the core shed from the field to avoid drying out of samples and subsequent reduction in volume.

As described, the wet and dry bulk density, and free moisture content formulae are in accordance with standard industry practice.

11.4.1 Xstrata methodology

A dedicated density laboratory was built at the Vila São José field office to expedite sample density measurement. The laboratory is equipped with three electric thermostatic furnaces, a digital scale, gas stove with two burners and aluminium containers for drying samples.

To determine the wet density, core samples (10 cm to 15 cm in length on average) were wrapped in plastic (PVC film) to retain moisture and prevent the sample from drying out. The sample was weighed on a digital scale and then inserted into a large cylinder containing water; the volume of water displaced by the sample was transformed to grams (1,000 mℓ of water = 1,000 g).

To determine dry density, samples were dried in an electric oven, at an average temperature of 250°C, in two sessions of one hour and 15 minutes. In between sessions, samples were weighed to check if the moisture was completely removed from the sample. Once the dried weight was found to be stable the sample was weighed on a digital scale and then inserted into a large cylinder containing water; the volume of water displaced by the sample was transformed to grams (1,000 mℓ of water = 1,000 g).

The results for each sample were initially collected on paper before being added to the digital database once the bulk density and moisture content were validated.

Density data validation used the following criteria:

- Visual detection of poor data such as negative moisture content or moisture content in excess of 70%. Checks for data entry error were made.
- Bulk density values less than 0.95 g/cm^3 are in principle were considered erroneous and checked. The validation criteria was based on mathematical analysis with acceptance of ±5% from a reference density (density of water 1.00g/cm^3)
- Standards usage – one standard sample was inserted for every 20 samples. The standards consisted of rock samples from the targets being studied. All of the standards analysed in early 2008 were within acceptable limits (±3 standard deviations or SD).

Table 11.1 shows the estimated wet and dry bulk densities and moisture content grouped by facies for samples predominantly from the SDT deposit, but also includes samples from the VDS and PP deposits.

Table 11.1 Bulk density values and moisture content for SDT (2008)

Fácies	Deposit	BD wet	BD dry	Moisture %	No	Deposit
SOIL	SDT	1.94	1.47	24.60	7	SDT+VDS
PIS	SDT	2.20	1.77	20.36	12	SDT+VDS
FRC	SDT	2.38	2.02	15.36	51	SDT+VDS
RL	SDT	2.08	1.51	27.88	156	SDT
YL	SDT	1.90	1.27	33.55	198	SDT
RT	SDT	1.98	1.37	31.15	628	SDT

Fácies	Deposit	BD wet	BD dry	Moisture %	No	Deposit
OT	SDT	1.78	1.15	35.74	348	SDT
GT-1	SDT	1.66	1.06	35.86	287	SDT
GT-2	SDT	1.83	1.10	35.20	814	SDT
TZ-1	SDT	1.69	1.10	35.52	125	SDT
TZ-2	SDT	1.72	1.16	32.60	187	SDT
GT-3	SDT	1.77	1.27	28.60	147	SDT
SAPR	SDT	1.78	1.27	28.64	308	SDT
TLC	SDT	2.02	1.61	20.59	309	SDT
WHZ	SDT	2.10	1.82	13.94	21	SDT
HZ	SDT	2.50	2.44	2.47	92	SDT
SIL	SDT	2.55	2.52	1.25	3	SDT
MSD	SDT	1.97	1.52	22.60	116	SDT+VDS
SSAP	SDT	1.99	1.57	21.16	18	SDT
SLX	SDT	2.36	2.21	7.17	17	SDT+VDS
MSAP	SDT	1.88	1.34	30.23	7	SDT
WGN	SDT	1.77	1.21	31.57	3	VDS
GN	SDT	2.72	2.67	2.01	33	SDT+PP
GLOBAL	SDT	2.02	1.58	23.39	3,887	SDT

Source: Xstrata Internal Memorandum. BD – Bulk Density Project Araguaia – Dates 2008 21/04/2008

11.5 Sample preparation and analysis

Sample preparation was completed in the following steps:

- Weighing
- Drying on aluminium trays at 105°C for at least 24 hours (longer if necessary)
- Crushing with Rhino jaw crushers to 95% passing 2 mm
- Three-step homogenization and splitting on a large Jones splitter (16 chutes, each 2 cm wide) to obtain a 350 g subsample (on average) for pulverisation
- Bagging the coarse reject for backup
- Pulverization of the 350 g sample with an LM-2 pulveriser to 95% passing 106 microns (150 mesh)
- Three step homogenization and splitting on a small Jones splitter (24 chutes, each 1 cm wide) to obtain a 20 g to 30 g subsample (on average) for assaying
- Bagging the pulp reject for backup.

Pulp samples were transported in a company truck to the SGS Geosol laboratory in Parauapebas from where SGS Geosol dispatched them to Belo Horizonte by TAM cargo from Marabá. Coarse and pulp rejects were stored on site at the Vila São José camp.

Upon arrival at SGS Geosol in Belo Horizonte, batch data were entered into the laboratory LIMS system.

Pulp samples were dried at 105°C for eight to 12 hours. Pulp aliquots of 2 g were mixed with similar amounts of lithium metaborate flux, weighed and fused on a small press to form 4 g beads. The beads were reweighed to determine loss on ignition (LOI) and assayed for Ni, Co, Fe, Cu and total oxides XRF on an automated Phillips XRF unit. Detection limits are summarised in Table 11.2 below.

Table 11.2 Suite of constituents for method XRF79C and PHY01E

Element	Detection limit	Element	Detection limit	Element	Detection limit
Al_2O_3	0.10%	Fe	0.007%	Pb	0.01%
Cu	0.01%	P_2O_5	0.01%	Cr_2O_3	0.01%
Ni	0.008%	Zn	0.01%	MnO	0.01%
TiO_2	0.01%	Co	0.005%	SiO_2	0.10%
CaO	0.01%	MgO	0.10%	LOI	-45%

11.6 Check umpire assay analysis

Where primary analysis was undertaken at the SGS Geosol laboratory in Belo Horizonte, check assays were conducted on selected samples at SGS and ALS laboratories in Canada.

Xstrata quality control (QC) procedures dictated that 5% of all laterite samples be sent for check analyses of Ni, Co, Fe and major oxides to at least one umpire laboratory. A total of 5,364 check samples from all the drilling programs were submitted for analysis. For all shipments, blind standards and blanks were inserted according to procedure.

11.7 Laboratory certification

SGS Geosol is independent of HZM and the sample preparation laboratory is located at:

- SGS Geosol Parauapebas
  Rua B, nº 50 Quadra 140 – Bairro Cidade Nova
  CEP: 68515-000 - Parauapebas/PA
  Tel: (94) 3346-1773/6644
  Fax: (94) 3346-2301

SGS is independent of HZM and the analytical laboratory is located at:

- SGS Geosol Laboratorio Ltda
  Av Mario Fonseca Viana, 120
  Bairro Angicos, Vespasiano, Minas Gerais
  Brazil

The SGS Geosol laboratories listed are ISO 9001:2008; ISO 14001:2004 (ABS 32982 and ABS 39911) certified.

11.7.1 Umpire/lab check laboratory

SGS Lakefield Research
185 Concession St, Lakefield, ON K0L 2H0
Canada

ALS is independent of HZM and its laboratories are located at:

- ALS MineralsLtda
  Rua São Paulo, 685, Célvia
  Vespasiano
  Belo Horizonte, Minas Gerais
  Brazil, 33200-000
- ALS Minerals
  2103 Dollarton Hwy

North Vancouver, British Columbia
Canada, V7H 0A7

All ALS laboratories listed are ISO 9001 and ISO 17025 certified.

11.8 Results of Quality Assurance/Quality Control

Quality Assurance (QA) describes the confidence in validity (i.e. data reflects what it is supposed to represent) and correct storage (i.e. data is stored accurately and may be recovered easily and without error) that is perceived for a given dataset. QC procedures were in place by Xstrata to ensure that a high level of QA was achieved.

The first batch of standards used by Xstrata originated from the Koniambo nickel project in New Caledonia.

Commencing in January 2006, Xstrata used standards prepared from material originating from the deposits at Araguaia. Four standards were made and the average values for each standard were confirmed in 2006 by SGS Geosol with 15 analyses per standard and the results were compared with four other laboratories.

In February 2007, new standards were prepared by SGS Geosol in Belo Horizonte from material originating from the SDT and VDS deposits. The average values for each standard were confirmed in 2007 by SGS with eight analyses per standard and the results compared with four other laboratories. Extensive check analyses from a minimum of two additional laboratories were performed.

Table 11.3 shows the recommended values for all standards used by Xstrata. Standards and blanks were inserted at a rate of one every 20th sample.

Table 11.3 Standards with recommended values for key elements

Date	Source	Standard	Ni (%)	Co (%)	Fe (%)	MgO (%)
2004/2006	Koniambo, New Caledonia	KLJA	1.68	0.334	48.9	0.66
		KSDC	2.27	0.036	n/a	n/a
		KLJA-2	1.40	0.182	42.7	4.01
		KSTB-2	2.50	0.083	15.26	22.06
2006/2007	Araguaia, Brazil	NILIM	1.13	0.158	40.99	2.45
		NISONHO	1.55	0.042	13.43	24.92
		NITAPA 1	1.48	0.039	16.07	17.16
		NITAPA 2	1.47	0.041	16.19	16.95
2007	Araguaia, Brazil	SYL	1.29	0.188	37.24	1.22
		STZ-1	0.72	0.043	19.36	19.26
		SGT-2	1.11	0.021	8.98	28.21

11.8.1 Results – standards, blanks and duplicates

A total of 4,383 standards and 4,409 duplicates were submitted for analysis.

Criteria for batch acceptance/rejection

Assay batches were passed or failed according to the following criteria:

- If one Ni or Co standard (but not both) fails between two and three standard deviations and no other failure occurs in the batch, the batch is accepted.

- If adjacent Ni or Co standards (but not both) fail between two and three standard deviations in a single batch, the standards are classed as failures. If the two standards occur in two different but adjacent batches, the laboratory is notified but the batches accepted.
- If more than two adjacent batches fail a Ni or Co standard, the laboratory is notified and all three (or more) standards are classed as failure.
- If both a Ni standard and a field blank fail in a single batch, both are classified as failures. Field blanks must show less than 300 ppm Ni.
- If a Ni standard fails beyond three standard deviations, the standard is classed as a failure.
- If a Co standard fails beyond three standard deviations, the standard is classified as a failure unless it is close to 0.005% Co.
- If both Ni and Co fail beyond two standard deviations, subject to item 6, the standard is classed as a failure.
- If a field blank fails in Ni in a minor way (between 50 ppm and 0.03% or 300 ppm), the analytical batch is examined for other QC failures in the same batch (Ni or Co more than two standard deviations). If no other failures no other action is necessary (contact the lab if failure occurs in multiple and successive batches).
- If a field blank shows a significant failure (greater than 300 ppm) in Ni and other QC samples also fail in the same batch, the most likely cause is sample miss-ordering and appropriate action is taken to find the extent of the miss-ordering.
- If a field blank alone shows a significant failure in Ni (greater than 300 ppm), the surrounding batches are classified as a failure. Verify whether the cause is sample miss-ordering of carry-over.
- If one standard in a batch fails beyond two standard deviations in any element other than Ni and Co, but Ni and Co are within two standard deviations, then the standard is accepted, but the laboratory is informed.
- If a standard fails beyond three standard deviations in any element other than Ni and Co, and either the Ni and Co are between two and three standard deviations, or another standard in the same batch fails beyond three standard deviations in any element other than Ni and Co, then the batch is classified as a failure.
- If a batch passes based on the Ni pass criteria, the values for Fe, SiO_2 and MgO from the standard samples submitted in the batch are reviewed. If one or more of the values for these oxides exceeds the mean by ±10% the results for the batch are flagged for examination to determine if the batch passes or if re-assay is required.

Results – duplicates

A total of 4,409 pulp duplicate pairs were analysed representing 4.27% of the total samples submitted by Xstrata for SDT and VDS. The results were graphed and examination of duplicate pairs showed no significant issues. Results were deemed to be acceptable if more than 90% of duplicates lie within 10% of the original value for each duplicate. The results indicated no significant issues.

In October 2007, 27 RC duplicates were sent to SGS Geosol. Results were deemed to be acceptable if more than 90% of duplicates prepared from coarse reject material should lie within 10% of the original value for each duplicate. The results, based on this limited dataset, indicated no significant issues.

11.9 Results – umpire analysis

All check analysis shipments were carefully chosen to represent mineralised holes with a wide geographical and temporal distribution. Overall, more than 5% of the total samples were sent for check analysis. The secondary laboratories were ALS Chemex (2004 to 2007) and SGS Lakefield (2007) both of which are in Canada.

Any discrepancies between SGS Geosol and the check laboratory results were investigated. The linear methodology was used to calculate the bias between the Primary and the Secondary laboratory (the bias should not have exceeded 10% to be considered acceptable).

A total of 1,306 laboratory check pulp samples from the SDT deposit covering the period of 2005 to 2007 were sent to ALS Chemex for analysis. A total of 21 assay pairs were rejected, thus 1,285 sample pairs (ALS Chemex vs. SGS Geosol) were charted for Ni, Fe, SiO_2, MgO, Al_2O_3 and Co in Figure 11.2. The charts for Ni, Fe, SiO_2, MgO, and Al_2O_3 show very good correlation between the paired assay values. Cobalt, on the other hand, shows significant discrepancy with ALS Chemex assays, being systematically lower than SGS Geosol values with increasing Co grade. As a result of this large relative bias, approximately 900 pulp samples were sent to SGS Lakefield for check analysis in 2007. Of this total, some 416 samples from the SDT deposit were included.

A total of 416 SGS Lakefield – SGS Geosol assay pairs for Co, Ni, Fe, SiO_2, MgO, and Al_2O_3 assay pairs were analysed in 2007 and are charted in Figure 11.3. Ten pairs were rejected. Figure 11.3 (for Co) shows a high degree of correlation between the two sets of analyses. The SGS Geosol analyses for Co are considered to be acceptable. The Ni, Fe, SiO_2, MgO, and Al_2O_3 charts all show a high degree of correlation and constraint about the 1:1 correlation trace.

ALS Chemex subsequently demonstrated to Xstrata that the issue with Co analysis had been corrected and was under control to Xstrata's satisfaction. ALS Chemex was used as the secondary laboratory for duplicate assays in 2008.

Figure 11.2 Umpire laboratory results for SGS Geosol vs ALS

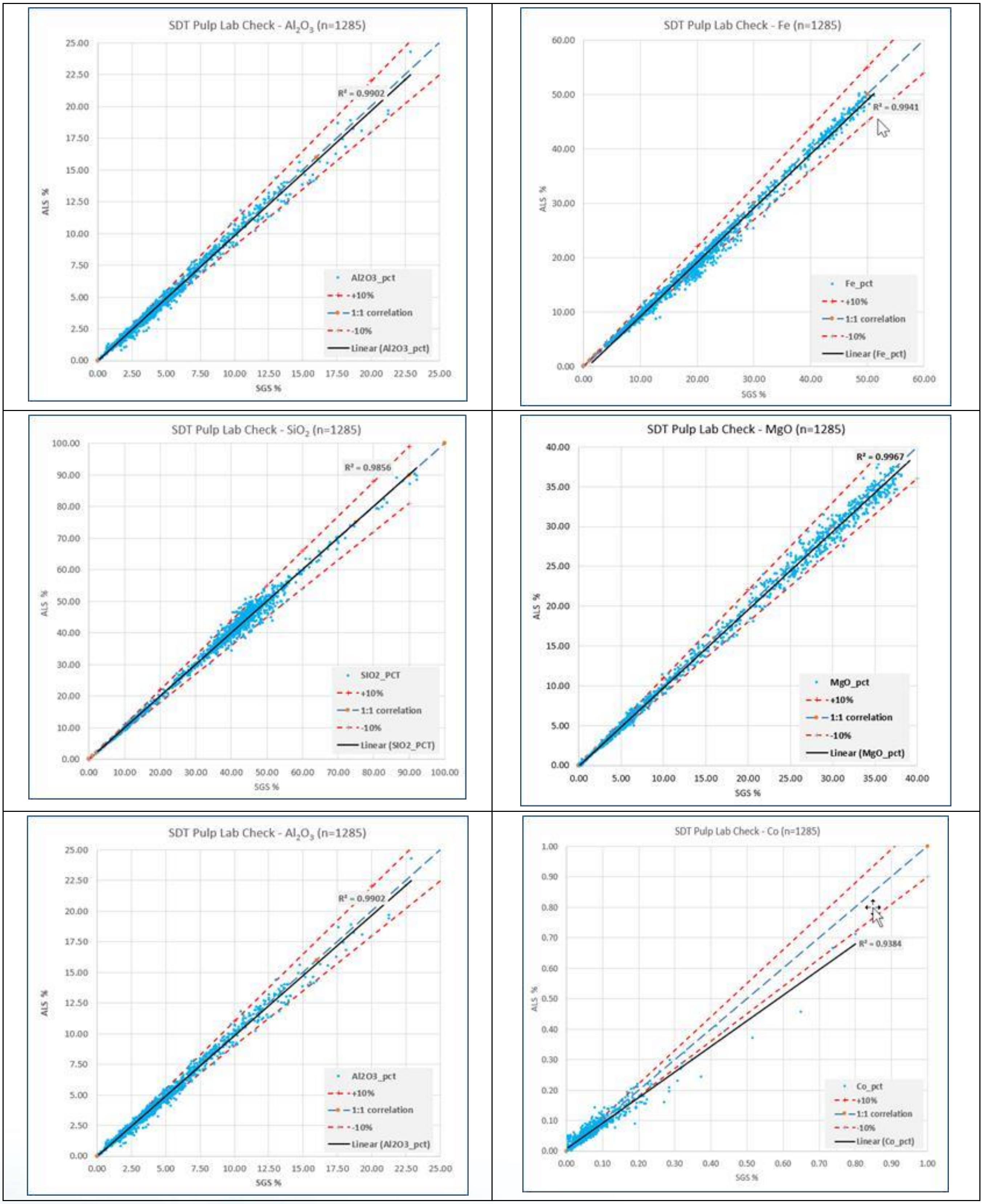
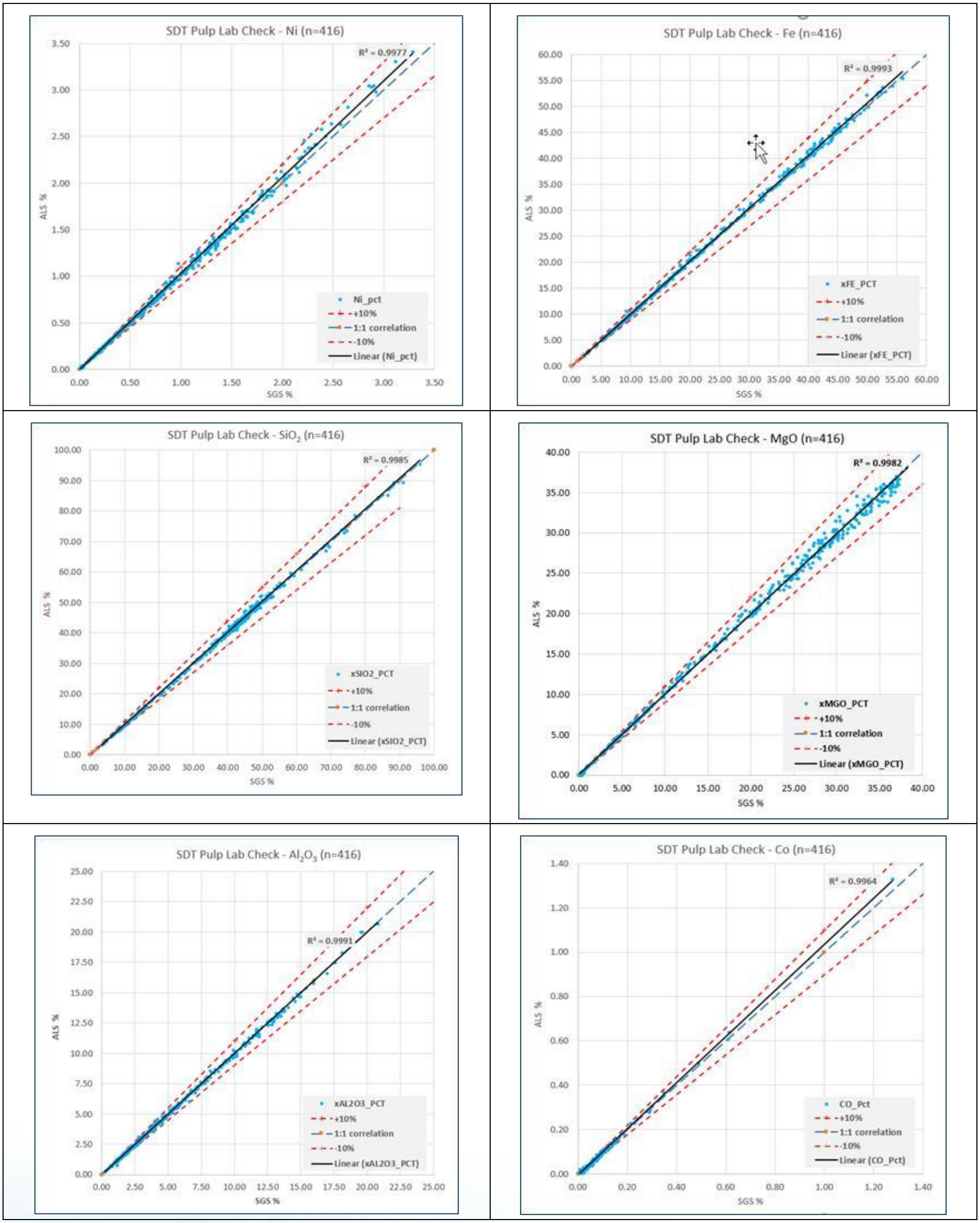


Figure 11.3 Umpire laboratory results for SGS Geosol vs SGS Lakefield



11.10 Author’s opinion

With regards the adequacy of the sample preparation, security, and analytical procedures the author concludes that the procedures as described are acceptable and that the resulting records subject to Xstrata’s validation checks are suitable for use in Mineral Resource estimation.

12 DATA VERIFICATION

12.1 Introduction

HZM's S. Heim and R.F. Billington conducted a thorough due diligence of the STD, VDS and PP deposit data during the first quarter of 2014. This work included an initial visit to the Xstrata office in Belo Horizonte to get an overview of the project, copy project files from the server, and arrange a field visit.

In summary, the due diligence included:

- Collar locations – independent checking of 53 collar locations
- Comparison of drill core with core logs for 102 diamond drillholes and review of core storage facility
- Review of original drillhole collar survey files
- Review of digital drillhole logs against original records for 103 drillholes
- Review of database assay results and cross-check with analytical certificates
- Review of QAQC procedures and results
- Review of density measurement procedures
- Review of original airborne geophysical survey data and reports.

12.2 Diamond drillholes

A visit was made to the main core storage facility at the field office in São José do Araguaia to ensure the presence of all drill core by checking identification tags and associated information. With a few exceptions, all drill core was accounted for.

12.3 Drillhole collar survey check

A total of 53 diamond drillhole locations were checked in the field. The check coordinate readings were taken using a Garmin 60 CSX handheld GPS. On average there was a difference of -6.34 m in the easting, 1.15 m in the northing and -5.40 m in the elevation. HZM concluded that based on the collar checks there is no reason to suggest that the total station topographic hole collar survey is not acceptable.

12.4 Comparison of core logs with drill core

A total of 102 holes (4,612 m and 4,914 samples) were selected to visually compare the core with the logs. The drill core boxes were laid out and the core compared with the logs.

Basic checks completed by HZM included:

- Core descriptions
- Sample ID and lengths
- Recovery
- Hole depth blocks and core box identification tags.

The logs were found to correlate well with the core, and the sampling, and the core box identification tags were seen to be complete.

12.5 Comparison of digital and original core logs

Digital core logs were compared with the original core logs for 103 drillholes and found to accurately reflect the original core log. During the examination of logging records HZM staff paid particular attention to the following:

- Drillhole identification
- Logging of lithology
- Sampling intervals and numbering.

12.6 HZM conclusions

HZM concluded the following from the due diligence of the data and core storage facility at ANN:

- The original drill logs were observed by HZM staff and were found to correlate well with the core and the sampling, and the core box identification tags were seen to be complete.
- Based on the drillhole collar checks, HZM staff believe the total station topographic hole collar survey data is representative and acceptable for use in resource estimation.
- Over 60,000 reject sample pulps are catalogued in the warehouses as well as reject samples. Given the volume of reject pulps and samples observed, HZM considers that the majority, if not all, of the core reject pulps and samples are still stored on site
- HZM reviewed a total of 317 certificates of analysis (2,450 catalogued to date). Results for 859 QAQC samples identified in 288 certificates were compared to the corresponding digital results in the ANN master assay database as were the assay results for 1,022 core samples in an additional 24 certificates of analysis. The certificates cover a date range from December 2004 through September 2007. A total of 15 samples displayed database/digital assay results for one or more elements that did not match the certificate.

12.7 QP verification

Verification of the SDT data by the author occurred in in two phases. In 2016 the author reviewed the digital drillhole data, assays and geological interpretation wireframes as part of the review process for the MRE undertaken by L. Farley and L. Olssen of Snowden.

On 6 and 7 August 2019 the author made a site visit to the SDT deposit and the field office in São José do Araguaia where the drill core and sample rejects are stored. The visit was made in the company of S. Heim who, since 2012, has been the resident geological manager for HZM during their evaluation of the Araguaia deposits and undertook due diligence review of the SDT geological and drillhole information. The deposit area on the rainforest plateau is currently covered with forest re-growth and access is now limited to a single 4x4 vehicle track that traverses the deposit from north to south. It was possible to identify eleven drillhole collar monuments from the metal tags remaining; record co-ordinates with a Garmin 62sc instrument and confirm that the location information in the database was correct.

At the field office in São José do Araguaia it was possible to confirm that HZM’s conclusions made in 2014 as to the status and security of drill core and samples, are still valid.

12.8 Qualified Person’s opinion on the adequacy of the data for the purposes used in the technical report

The Qualified Person concludes that the data verification results provide assurance that the data is reliable and adequate for use in Mineral Resource estimation for SDT. As described and from the checks made, the Qualified Person concludes that the Project resource database meets industry standards and is compatible with the JORC and CIM codes for public reporting as required under NI 43-101.

13 MINERAL PROCESSING AND METALLURGICAL TESTING

13.1 Introduction

Process flowsheet development for nickel laterite deposits is dependent upon the metallurgical characteristics (both chemical composition and physical form) of the laterite mineral types (limonite, transition, and saprolite). To correctly characterise the material, it is necessary to carry out the appropriate metallurgical testwork and through this establish an appropriate flowsheet. Selection of a suitably representative sample set from the main lithologies in each deposit (and the associated mineral resource) is key to this process.

It should be noted that the testwork conducted, and presented in this Technical Report, on the SDT deposits has been conducted by Xstrata and its consultants and reported in AMEC (2008) prior to its acquisition by HZM. HZM has not conducted any testwork on the SDT deposit and no process route has been finalised by HZM for the deposit. The following is extracted from AMEC (2008), reviewed and amended by the Qualified Person for inclusion in this Technical Report.

Testwork to date has focussed on pyrometallurgical methods.

13.2 Ore characterisation (AMEC, 2008)

The ore from the SDT and VDS deposits was thoroughly sampled for chemical and mineralogical characterization as well as metallurgical processing behaviour. Since several different facies are present both at SDT and VDS, representative samples were collected for all the dominant facies. These samples were analysed independently as well as blended into mineable composites.

13.2.1 Chemical composition

The relative proportion of the facies for the SDT deposit has been evaluated at a cut-off grade of 1.2% nickel. These results are tabulated in Table 13.1.

Table 13.1 Facie abundance/ chemistry, SDT deposit

Facies	Percent (%)	Ni (%)	Co (%)	Fe (%)	SiO_2 (%)	MgO (%)	Al_2O_3 (%)	Ni/Co ratio	SiO^2/MgO
GT-2	35	1.71	0.05	17	43	15	3.8	33	2.9
SAPR	18	1.59	0.03	10	43	26	2.2	63	1.7
GT-1	16	1.98	0.05	16	46	13	3.7	42	3.5
OT	9	1.60	0.08	28	34	6	5.2	19	5.7
GT-3	7	1.65	0.03	12	43	23	3.4	49	1.9
TZ-1	4	1.61	0.07	22	35	15	4.9	25	2.3
TZ-2	4	1.62	0.04	16	40	19	3.7	37	2.1
RT	4	1.54	0.12	29	34	4.2	6.3	13	8.1
Others	3	1.50	0.10	36	20	5	6.3	15	4.0
Total	**100**	**1.60**	**0.05**	**18**	**41**	**16**	**3.8**	**31**	**2.6**

The Ni:Co ratio is significant since cobalt is considered an impurity in the ferronickel product. The recovery of cobalt during smelting is lower than that for nickel, resulting in a Ni:Co ratio in ferronickel that is approximately 30% higher than the ratio in *ore*. Red tapa (RT), red limonite (RL) and yellow limonite (YL) facies are particularly high in cobalt and the mining rate of these will need to be closely controlled, possibly through the inclusion of mining stockpiles.

Metallurgical characterisation of the SDT and VDS ores included both laboratory and pilot plant testing. Both programs were focused on the upgrading potential of the deposits and key slag properties. Laboratory testing was carried out on split drill core from the exploration programs at SDT and VDS. Pilot testing was conducted on bulk samples collected from the same deposits using a 90 cm diameter auger.

The chemical composition of the SDT and VDS deposits exhibits some features that require particular attention during the metallurgical plant process design:

- Alumina: The present of Al_2O_3 reduces the melting point of the slag and increases the viscosity. The combined effect was addressed in the bench-scale program and during pilot plant testing.
- Cobalt: SDT and VDS have a relatively high cobalt content, resulting in a low Ni/Co ratio in the ferronickel product.
- Copper: Copper is also relatively high, three to ten times higher in the ferronickel product than for Koniambo.
- Sulphur and phosphorous: These elements are removed from the final product during refining.
- SiO_2/MgO ratio: Both SDT and VDS have an ore composition with unfavourable silica:magnesia ratios. Therefore, a mine plan will need to provide an appropriate blend and may require rejection of some unfavourable material.

Mineralogy has been discussed in Section 7.3.

13.3 Processing method (AMEC, 2008)

Three flowsheet options were considered in the trade-off study to select the process to be used as the basis for the 2008 Scoping Study:

- Nickel smelting technology (NST)
- Rotary kiln/electric furnace (RKEF)
- Blast furnace nickel pig iron (NPI).

The factors considered in the trade-off study were capital expenditure (capex); operating expenditure (opex); and health, social, environment, and community (HSEC) performance and technical barriers. All three options were found to be similar with respect to capex; however, the opex estimate for the NPI process was found to be higher than that for the RKEF and NPI processes due to lower energy utilisation. The NST process was expected to provide the best HSEC performance, and the low liquidus temperature of the SDT and VDS deposits was considered to be a potential barrier to maintaining covered bath operation in the RKEF process. On the basis of this analysis, the NST process was selected for the purposes of the Scoping Study.

13.4 Metallurgical testwork (AMEC, 2008)

Laboratory, bench-scale and pilot plant testing were undertaken.

Based on bench-scale laboratory results and the outcomes of the process flowsheet trade-off study, pilot test campaigns were carried out to confirm the processing behaviours and establish the process design basis for the metallurgical plant.

Two sets of metallurgical samples were characterised using a full suite of bench scale methods. The first set of samples was derived from split drill core from the SDT and the VDS deposits, while the second set of samples was taken as sub-samples from the metallurgical bulk samples collected from the two deposits.

13.4.1 Laboratory testing

The range of tests and measurements conducted on the samples described above are listed below:

- Moisture determination
- Particle size distribution (wet screening at 45 µm, followed by dry screening of the oversize fractions)
- Chemical screen analysis using the sizing method described above
- Bond Work Index (BWI) measurement
- Abrasion Index measurement
- Thermo-gravimetric analysis/ Differential thermal analysis (TGA/DTA) to measure weight loss and energy flow as a function of temperature
- Crystalline water determination
- Sticking temperature determination under oxidising and reducing conditions
- Reduction smelting behaviour as a function of carbon addition and temperature.

The results of these laboratory characterisation tests indicate that the deposit is comparable to typical laterite deposits (e.g. Koniambo, Falcondo), with the following exceptions:

- The projected slag composition leads to slag liquidus temperatures that are estimated to be approximately 100°C lower (as a result of the silica:magnesia ratio, the iron content and the alumina content)
- The BWI is lower (consistent with the low rocky fraction of the deposit)
- The size distribution is somewhat finer (consistent with the predominantly earthy saprolite and transitional facies present in the deposits).

The test results confirmed the process design basis that was developed based on the Koniambo project. A total to 15 t of on-spec reduced calcine was produced.

13.4.2 Bench-scale testing

In addition to the drill core blends, two individual facies were also selected for bench-scale testing to assess the potential for upgrading based on the maximum number of intersections in the marginally economic range of 1.0 to 1.2% Ni. The selected facies are Saprolite Rock/Green Tapa 2 from SDT and Saprolite Rock/Transitional 2 from VDS. The chemical screen analysis testing indicates some potential for upgrading based on selective grinding and size classification.

13.4.3 Pilot plant testing

Ore upgrading pilot tests were carried out at FLSmidth's facility in Allentown, Pennsylvania. Bulk samples from SDT and VDS were processed through an air-swept hammer mill operating in conjunction with a dynamic air classifier. The results showed a slight potential for upgrading with a target cut size in the range 500 µm to 1,000 µm.

Testing of the four main unit operations of the process was carried out in two pilot plants. The grinding/drying, calcining and reduction steps of the NST process were pilot tested at the Polysuis R&D centre in Ennigerloh, Germany. A representative 25 t bulk sample from SDT was processed during a one-week campaign. The ore feed rate to the pilot plant was 250 kg/h (dry basis).

As particle size increases, nickel grade consistently decreased in all the samples tested. A systematic decrease in iron content and silica:magnesia ratio are also observed.

The reduced calcine was shipped to the Mintek pilot plant in Randburg, South Africa to pilot test the direct current (DC) smelting step. A custom designed and built 1 m diameter pilot furnace equipped with continuous ring of waffle copper coolers in the slag zone was utilised for the testing. All the reduced calcine was processed over the period of one week. The furnace operated at a nominal feed rate of 250 kg/h and a nominal power level of 400 kW, corresponding to a power density of just over 500 kW/m^2. Ferronickel was produced at the target grade of 35% Ni with slag losses in the range of 0.15% Ni. Slag-line sidewall heat fluxes were in the expected range of 50–100 kW/m^2 and the furnace operating temperature averaged 1,600°C. A total of approximately 750 kg of ferronickel was produced. This pilot test also confirmed the process design utilised in the design of the metallurgical plant.

13.5 Conclusion

Testwork results, and the proximity and similarities with the HZM Araguaia Project, suggest that the SDT deposits may be amenable to a rotary kiln electric furnace (RKEF) process, made up of unit processes derived from other process industries and supported by conventional ancillaries. The mineralised material (ore) is treated using a thermal drying, calcining, reduction and smelting process to produce ferronickel metal alloy and waste slag. However, this has not been finalised and no definitive process route for the SDT Project has been confirmed.

14 MINERAL RESOURCE ESTIMATES

14.1 Introduction

In 2015, Mineral Resource estimates were initially reported by HZM as “historical” (Osmond, 2015) for the combined SDT, VDS and PP deposits. In order to report separate, current Mineral Resource estimates for the SDT and VDS deposits, Snowden subsequently completed re-estimates in 2016.

At a cut-off grade of 0.90% Ni, a total of 14.2 Mt at a grade of 1.31% Ni is defined as a Measured Mineral Resource and a total of 56.0 Mt at a grade of 1.29% Ni is defined as an Indicated Mineral Resource. The combined tonnage has been estimated at 70.2 Mt at a grade of 1.29% Ni for Measured and Indicated Mineral Resources, using a cut-off grade of 0.90% Ni. A further 2.6 Mt at a grade of 1.13% Ni is defined as an Inferred Mineral Resource at a cut-off grade of 0.90% Ni. MRE classifications are reported in accordance with CIM Definition Standards (CIM, 2014).

Snowden is unaware of any issues that materially affect the Mineral Resources in a detrimental sense.

14.2 Method

The Resource estimate was completed by Snowden and was prepared in the following steps:

- Data preparation
- Geological interpretation and horizon modelling provided by HZM
- Establishment of block models and definitions
- Compositing of assay intervals
- Exploratory data analysis and variography
- Ordinary kriging estimation method
- Model validation
- Calculation of dry density
- Classification of the estimate with respect to the CIM Definition Standards for Mineral Resources (CIM, 2014)
- Resource tabulation and resource reporting.

14.3 Drillhole data

HZM supplied Snowden with Glencore-Xstrata data in an Access database. Snowden imported the relevant tables into Datamine Studio 3 by importing collar surveys, sample identifiers and assays. Validation routines were run inside Datamine Studio 3 to identify any discrepancies such as duplicate or missing records, and no significant issues were identified.

14.4 Geological interpretation

Wireframes formerly generated by Glencore in GEMS were supplied by HZM. Snowden reviewed and validated the wireframes before use and found no significant issues.

Horizon surface extrapolations were constrained by a distance of 25 m from the perimeter drillholes.

A consistent set of codes was used to define Limonite (100), Transition (200), Saprolite (300), Fresh rock (500).

Only limonite, transition and saprolite are mineralised and hence grades were not estimated into the other domains.

14.5 Compositing of assay intervals

Compositing was run within the coded horizon fields to ensure that no composite intervals crossed any lithological or grade boundaries. To allow for uneven sample lengths within each of the horizons, the Datamine composite process was run using the variable sample length method. This adjusts the sample intervals, where necessary, to ensure all samples are included in the composite file (i.e. no residuals) while keeping the sample interval as close to the desired sample interval as possible.

The compositing process was checked by:

- Comparing the lists of horizon domain values in the raw and composite files, which matched.
- Comparing the sample length statistics in the raw and composite files. The two total length values matched and the mean composite interval was 1 m.

An assessment of the Coefficient of Variation (CV – ratio of the standard deviation to the mean) parameter resulted in the decision to top-cut selected constituents (CaO and MgO) during grade estimation for some horizons. The top-cut values and percentage of sample cut are provided in Table 14.1.

Table 14.1 Top cuts applied during grade estimation

Horizon	CaO top cut (%)	No. affected (%)	MgO top cut (%)	No. affected (%)
100	0.45	0.10	25.00	0.92
200	1.00	0.57	-	-
300	1.00	1.29	-	-

14.6 Variography

Variograms were generated to assess the grade continuity of the various constituents and as inputs to the ordinary kriging algorithm used to interpolate grades. Snowden Supervisor V.8 software was used to generate and model the variograms.

Snowden elected to use the Datamine Unfold process to address the impact of the undulations on the modelling of variograms and the estimation of grades.

Variograms for unfolded nickel (Ni), cobalt (Co), iron (Fe) and oxide constituents (Al_2O_3, CaO, Cr_2O_3, MgO, MnO, SiO_2) were developed for each horizon and area, provided the data density was sufficient to support robust variograms. All variograms were modelled using the following general approach:

- The drillhole composites were unfolded and modelled using the unfolded coordinate fields
- All variograms were standardised to a sill of one
- Variograms were modelled using spherical variograms with a nugget effect and two structures. Snowden found that most nuggets derived from the downhole direction were exceedingly low, which is expected in the nickel laterite environment.

Nickel variograms are shown in Figure 14.1 to Figure 14.3.

Figure 14.1 Variograms for nickel – horizon 100

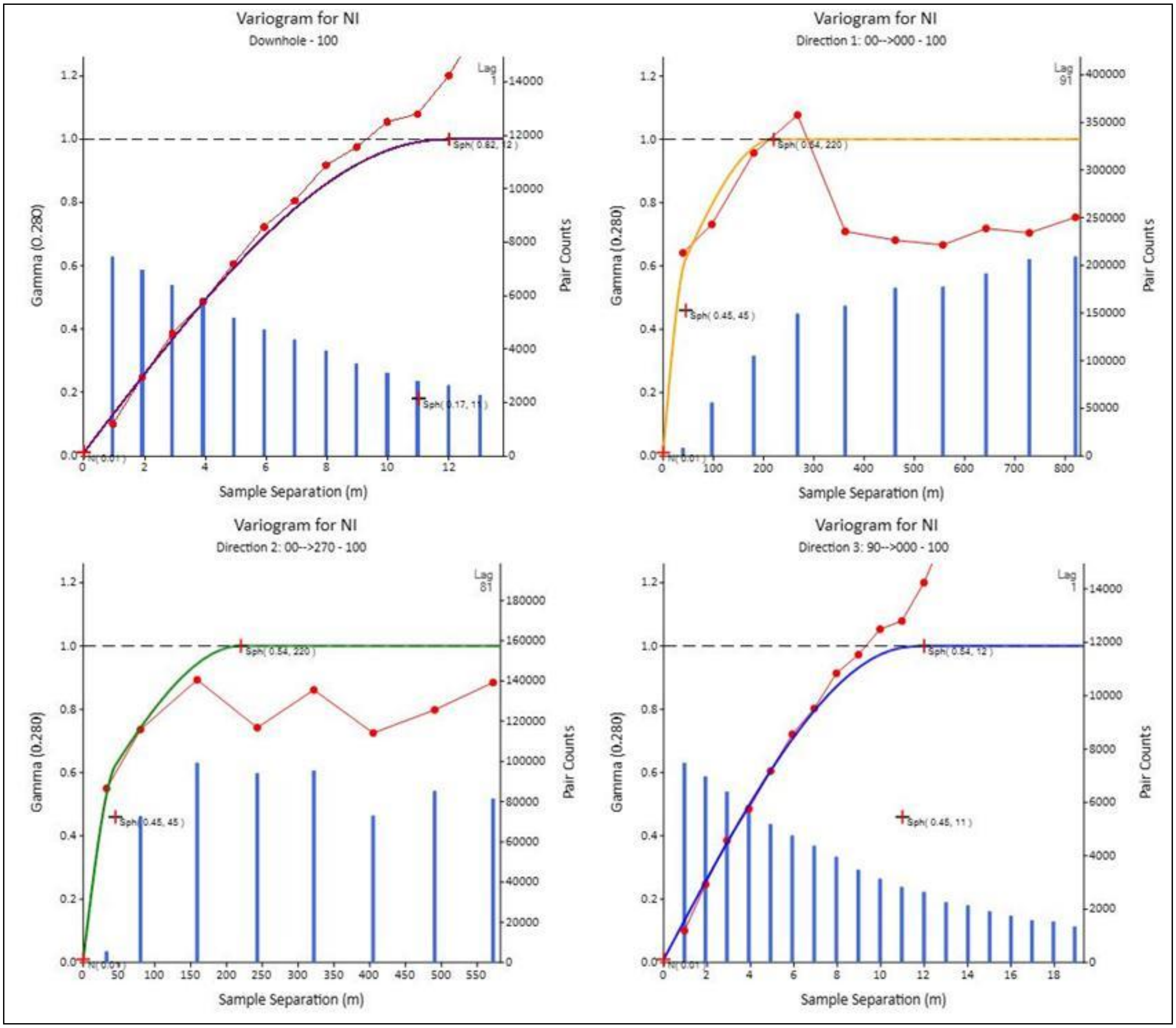


Figure 14.2 Variograms for nickel – horizon 200

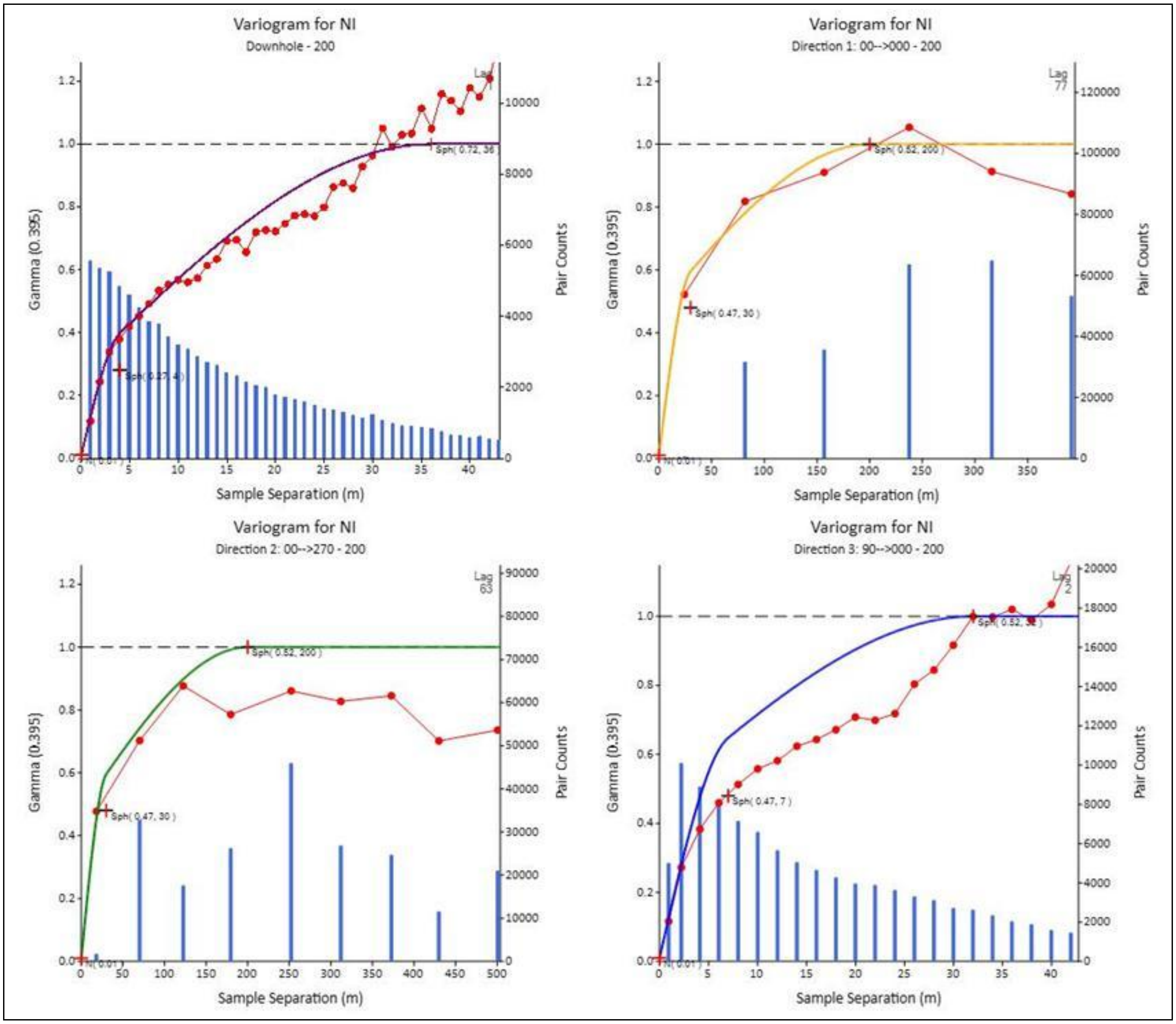
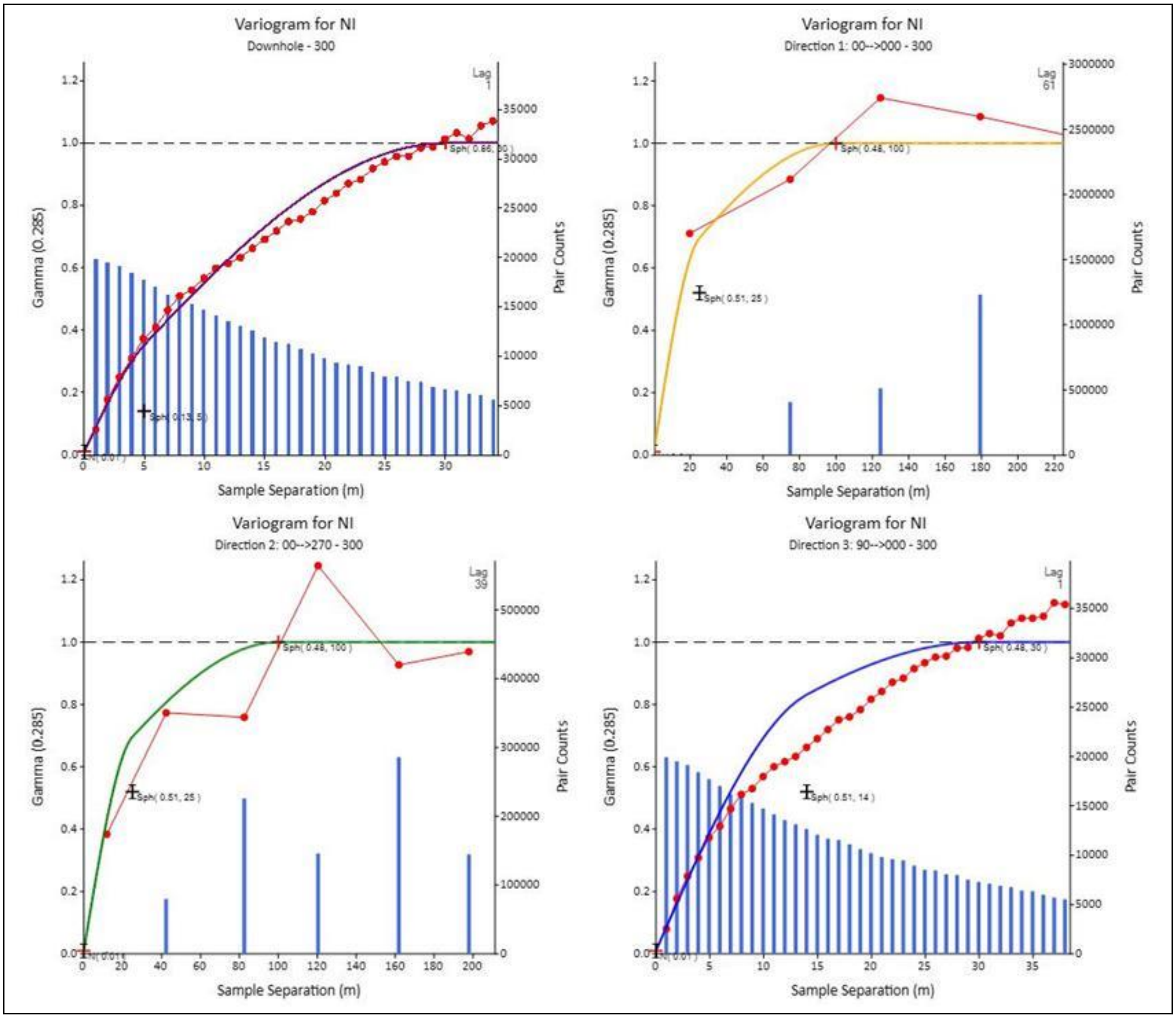


Figure 14.3 Variograms for nickel – horizon 300



14.7 Grade estimation

Estimation was completed for Ni, Al_2O_3, CaO, Co, Cr_2O_3, MgO, MnO, SiO_2 and Fe for each of the domains (100 = Limonite, 200 = Transition and 300 = Saprolite).

14.7.1 Block model definitions

The final model extents are listed in Table 14.2. The sample density was considered when selecting the parent cell size of 25 m x 25 m x 2 m (XYZ). In the vertical direction, the parent cell size of 2 mRL reflects the likely mining bench height.

Table 14.2 Block model definitions

Model definition	SDT
X Origin (mE)	682,500
Y Origin (mN)	9,239,000
Z Origin (mRL)	250
Maximum Easting (mE)	685,250
Maximum Northing (mN)	9,244,300
Maximum Elevation (mRL)	600

Sub-celling to 6.25 mE x 6.25 mN x 0.5 mRL was employed to honour the horizon wireframes.

14.7.2 Estimation method

Datamine software was used to unfold the composite data and estimate grades using ordinary kriging. Grades were estimated using variogram models for each attribute grouped by horizon. Hard boundary conditions were used to preserve the chemistry of each horizon.

14.7.3 Search parameters

The same search ellipse ranges and axis rotations were used with each of the grade estimates in order to maintain the ratios of the various constituents (metal balance) as consistent as possible. The search ellipse axis lengths were derived from the variogram modelling.

The distribution and density of the various attribute values within each of the domains are quite variable in areas around the edges of the mineralisation and for the transition horizon which is often thin and highly variable in thickness. As such, if a single search ellipse was applied for the estimation process, then a significant proportion of cells within the interpreted horizons would not be informed for all the grade fields. To ensure that each cell within the horizons includes an estimated grade value, a dynamic search volume approach using three search passes was used as described in the following section. Search parameters are presented in Table 14.3 below.

Table 14.3 Search parameters used for estimation

Area	Horizon	Orientation	Distance (Z) true thickness	Distance (X) along strike	Distance (Y) down dip
SDT	100	0° → 160°	2	200	200
SDT	200	0° → 270°			
SDT	300	90° → 000°			

14.7.4 Estimation settings summary

The key search ellipse and estimation parameters are summarised in Table 14.4.

Table 14.4 Estimation parameters

Estimation setting	Description/setting
Final model names	sdt1601v1.dm
Drillholes	Unfolded and coded drilling data in Datamine format with top cuts applied for selected variables
Boundary conditions	Hard horizon boundaries for all estimates
Top cuts	Applied to CaO and MgO
Search ellipsoid	Based on variograms ranges
Method	Ordinary kriging (parent cell estimation) with unfolding
Variograms	See Section 14.6
Dynamic search volumes	Yes
Minimum number of samples – volume 1	5
Maximum number of samples – volume 1	20
Search volume 2 factor	1
Minimum number of samples – volume 2	2
Maximum number of samples – volume 2	20
Search volume 3 factor	2
Minimum number of samples – volume 3	1
Maximum number of samples – volume 3	20
Octant searching	No
Block discretisation (XYZ)	8 x 8 x 2

14.8 Bulk density data

A combination of approximately 13,500 representative samples from each of the major laterite facies across all of ANN were used for bulk density determination.

Snowden investigated the relationship between measured density and major chemistry of the density samples and derived formulae to allow block dry density to be calculated from major chemistry block estimates. Samples were sorted by horizon and Microsoft Excel's LINEST (multiple linear regression) formula was then applied to create an equation for each horizon. The regression equations are:

- Limonite horizon 100:

$$\begin{aligned}SGREG = &- (Ni * 0.29277) - (Co * 0.04680) - (Fe * 0.01968) - (MgO * 0.01542)\\ &- (MnO * 0.00697) - (SiO_2 * 0.01069) - (Al_2O_3 * 0.01946)\\ &+ (Cr_2O_3 * 0.04493) + (CaO * 0.03887) + 2.74209\end{aligned}$$

- Transition horizon 200:

$$\begin{aligned}SGREG = &- (Ni * 0.07521) - (Co * 0.00307) + (Fe * 0.01905) + (MgO * 0.01450)\\ &+ (MnO * 0.02653) + (SiO_2 * 0.01159) + (Al_2O_3 * 0.01701)\\ &- (Cr_2O_3 * 0.05690) + (CaO * 0.01370) + 0.26261\end{aligned}$$

- Saprolite horizon 300:

$$\begin{aligned}SGREG = &- (Ni * 0.21763) + (Co * 1.15695) + (Fe * 0.00097) + (MgO * 0.00069)\\ &- (MnO * 0.06468) + (SiO_2 * 0.00313) - (Al_2O_3 * 0.00815)\\ &- (Cr_2O_3 * 0.08769) + (CaO * 0.03228) + 1.45035.\end{aligned}$$

The regression prediction was checked by calculating the regressed density values from actual assays: checking that the average calculated results were equal to the average of the density measurements; and comparing the predicted values with the actual density measurements by scatter plots.

14.9 Block model validation

The estimates were validated using:

- A visual comparison of the block grade estimates and the drillhole composite data
- Generation of vertical section and plan view plots of the estimates, naïve composite and de-clustered composite grades (where required), along with the number of composite samples available (slice or swath plots)
- A global comparison of the average composite (naïve and de-clustered) and the estimated grades (Table 14.5)
- A comparison of the correlations between constituents within the input composite data and the block model grade estimates.

The conclusions from the model validation work are:

- Inspection of the slice plots shows, for regions where there are substantive input composite numbers, good agreement in grade trends
- Statistical comparison of the model grades and the corresponding drillhole composite grades shows a good outcome for almost all constituents, with less than 2% difference for all domain for nickel (Table 14.5). The exceptions are for non-critical constituents.

The estimated models adequately preserve the correlations observed in the input statistics.

Table 14.5 Comparison of composite and estimated grades for Ni

Area	Horizon	Composite grade (%)	Estimated grade (%)	Difference (%)
SDT	100	0.53	0.53	0.0
SDT	200	1.30	1.31	0.8
SDT	300	0.83	0.84	1.2

14.10 Classification

The MRE was classified and reported in accordance with the CIM Definitions Standard on Mineral Resource and Mineral Reserves (CIM, 2014). The MRE is reported at a nickel cut-off grade of 0.90%, consistent with the reporting of Mineral Resources for the ANP.

Reasonable prospects for metal recovery by current technologies were reported by Xstrata (see Section 13).

The Mineral Resource classification criteria were developed based on an assessment of the following items:

- Nature and quality of the drilling and sampling
- Drilling density
- Confidence in the understanding of the underlying geological and nickel grade continuity
- Analysis of the QAQC data
- Confidence in the estimate of the mineralised volume
- The results of model validation

- The criteria listed in Table 1 Section 1 and Section 3 of the JORC Code (2012). The JORC Code is a reporting code used in Australia, however the parameters and classification system is analogous to CIM, 2014.

The resource classification scheme (whether Measured, Indicated or Inferred) adopted for the 2016 SDT MRE was based on the following.

- Mineralisation was classified as a Measured Resource where the drilling density was 40 mE x 40 mN (or less)
- Mineralisation was classified as an Indicated Resource where the drilling density was 80 mE x 80 mN (or less)
- Mineralisation delineated using a drilling density up to about 160 mE x 160 mN spacing was classified as an Inferred Resource
- Mineralisation outside of the mineralised envelope was not classified.

14.11 Mineral Resource reporting

The classified 2016 Mineral Resource has been reported using a 0.90% Ni cut-off grade and is provided in Table 14.6.

Table 14.6 MREs reported for SDT at 0.90% Ni cut-off as at August 2019

Category	Material type	Tonnage (kt)	Bulk density (t/m^3)	Contained Ni metal (t)	Ni (%)	Co (%)	Fe (%)	MgO (%)	SiO_2 (%)	Al_2O_3 (%)	Cr_2O_3 (%)
Measured	Limonite	915	1.30	10,912	1.19	0.11	33.40	5.44	25.98	7.13	1.64
	Transition	4,111	1.18	64,687	1.57	0.06	20.46	10.78	41.21	4.72	1.48
	Saprolite	9,269	1.26	112,274	1.21	0.03	12.96	22.62	42.80	2.68	0.99
Subtotal		**14,296**	**1.24**	**187,873**	**1.31**	**0.05**	**16.42**	**18.12**	**41.27**	**3.55**	**1.17**
Indicated	Limonite	4,208	1.34	45,645	1.08	0.13	37.01	4.30	20.67	7.71	2.07
	Transition	19,438	1.20	259,529	1.34	0.06	20.47	11.12	41.11	4.92	1.46
	Saprolite	32,325	1.29	364,353	1.13	0.03	12.35	23.70	42.92	2.64	0.92
Subtotal		**55,971**	**1.26**	**669,527**	**1.20**	**0.05**	**17.02**	**17.88**	**40.62**	**3.81**	**1.20**
Measured + Indicated	**Total**	**70,267**	**1.26**	**857,400**	**1.22**	**0.05**	**16.90**	**17.93**	**40.75**	**3.76**	**1.19**
Inferred	Limonite	642	1.38	6,777	1.05	0.08	34.39	4.73	22.33	8.25	2.38
	Transition	1,308	1.22	15,748	1.20	0.06	22.05	10.23	37.83	6.47	1.50
	Saprolite	730	1.30	8,001	1.10	0.03	12.20	22.64	44.30	3.10	0.87
Subtotal		**2,680**	**1.28**	**30,526**	**1.14**	**0.06**	**22.32**	**12.29**	**35.87**	**5.98**	**1.54**

Note: Mineral Resources are inclusive of Mineral Reserves. Totals may not add due to rounding.

15 MINERAL RESERVE ESTIMATES

No current Mineral Reserve is reported in this Technical Report.

16 MINING METHODS

The nickel deposits of the Pará State are near surface and suitable for conventional truck and shovel open pit mining. This has been the method put forward for the HZM Araguaia Nickel Project located approximately 150 km to the south. However, HZM has not conducted any mining method study for SDT, for this Technical Report.

17 RECOVERY METHODS

No recovery method has been investigated for the Project by HZM and reported in this Technical Report.

18 PROJECT INFRASTRUCTURE

No project infrastructure study has been completed for the Project by HZM and reported in this Technical Report.

19 MARKET STUDIES AND CONTRACTS

No market studies and contracts have been completed for the Project by HZM and reported in this Technical Report.

20 ENVIRONMENTAL STUDIES, PERMITTING, AND SOCIAL OR COMMUNITY IMPACT

Not applicable to the Project at this time. HZM has not submitted any permit applications to regulatory agencies for exploration or mining activities.

21 CAPITAL AND OPERATING COSTS

The capital and operating costs for the Project have not been investigated by HZM and reported in this Technical Report.

22 ECONOMIC ANALYSIS

No economic analysis is reported in this Technical Report.

23 ADJACENT PROPERTIES

There is no information from adjacent properties applicable to the Project for disclosure in this Technical Report.

24 OTHER RELEVANT DATA AND INFORMATION

There is no other relevant data and information to disclose.

25 INTERPRETATION AND CONCLUSIONS

The SDT licence acquired by HZM is within the Carajás Mining District, an active mineral exploration and mining region with advanced infrastructure and services to support development of the Project. The previous operator had completed a Scoping Study to evaluate the production of nickel from open pit mining and processing via pyrometallurgical methods.

HZM has recently completed a FS for the ANP property located approximately 150 km the south of SDT and is proposing open pit mining from numerous deposits and processing via the RKEF method. Additionally, in 2017, HZM purchased the Vermelho project, approximately 80 km to the northwest of SDT, and is currently progressing a PFS for that. HZM is familiar with the region and is well placed to consider what synergies exist in the development of the ANP, SDT and Vermelho projects.

The geological setting of the SDT deposit is well understood. The SDT deposit is orientated in a north-south direction. The mineralised portion extends for some 5,000 m (north-south) and is up to 900 m in width. A distinctive lateritic sequence is developed over ultramafic and mafic rocks. The sequence can be split into six main facies types: soil, ferricrete, limonite, transition, saprolite and fresh rock, as well as numerous sub-facies. Discrimination between the geological horizons is made using mainly iron, magnesium oxide, silica, alumina and nickel grades. The mineralised geological horizons are designated 100 (Limonite), 200 (Transition) and 300 (Saprolite).

Drilling on the SDT deposit was undertaken by Xstrata Nickel (2004 to 2007). The program started with a 320 m x 320 m spaced pattern, subsequently followed with complete coverage on an 80 m x 80 m grid with small areas of closer spaced drilling completed to evaluate short-scale variability. In the last stage of drilling, three areas of 40 m x 40 m drilling were completed. A total of 952 DD holes were completed for 48,845 m (42,092 samples). No drilling has been undertaken since this period.

Independent reviews of Xstrata's operations at SDT have found that survey, drilling, sampling procedures and sample preparation and analysis protocols were adequate to support the estimation of Mineral Resources.

At a cut-off grade of 0.90% Ni, a total of 14.2 Mt at a grade of 1.31% Ni is defined as a Measured Mineral Resource and a total of 56.0 Mt at a grade of 1.20% Ni has been estimated as an Indicated Mineral Resource. This gives a combined tonnage of 70.2 Mt at a grade of 1.22% Ni for Measured and Indicated Mineral Resources using a cut-off grade of 0.90% Ni. A further 2.6 Mt at a grade of 1.14% Ni is defined as an Inferred Mineral Resource at a cut-off grade of 0.90% Ni.

The metallurgical testwork completed to date is considered representative of the mineralisation available within the SDT deposit. The testwork completed has shown the mineralised material at SDT to be comparable to typical laterite deposits and amenable to pyrometallurgical processing.

Some basic environmental data has been collected previously that remains valid and can be used by HZM together with a site visit to design a full baseline programme. The previous socio-environmental studies carried out at SDT will be useful to guide new social and environmental studies in the region.

Open pit mining is typical for this type of nickel laterite project, is frequently employed and well understood throughout the industry, and is common practice in Brazil. Subject to the necessary studies and positive results, there is no reason why SDT cannot be extracted using this method.

26 RECOMMENDATIONS

The Qualified Person recommends that HZM should complete a review to ascertain the preferred strategy for incorporating SDT into HZM's other planned projects.

27 REFERENCES

Primary documents associated with this Technical Report are referenced below.

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Osmond, 2015	NI43-101 Technical Report on the Serra Do Tapa and Pau Preto Projects. Report prepared for Horizonte Minerals, 16 November 2015.

28 CERTIFICATE OF QUALIFIED PERSON

Andrew F. Ross

I, Andrew F. Ross, Executive Consultant of Snowden Mining Industry Consultants Pty Ltd, Level 5, 580 Hay St, Perth, Western Australia do hereby certify that:

- I am the author of the technical report titled "Amended NI 43-101 Technical Report on the Serra do Tapa Project, Pará State, Brazil" dated 3 September 2019, amended 31 March 2021 with an effective date of 3 September 2019 (the "Technical Report") prepared for Horizonte Minerals Plc.
- I graduated with an Honours Degree in Bachelor of Science in Geology from the University of Adelaide in 1972. In 1985, I graduated with a Master of Science degree in Mining and Exploration Geology from James Cook University of North Queensland. I am a Fellow of the Australasian Institute of Mining and Metallurgy. I have worked as a geologist almost continuously for a total of 47 years since graduation. I have been involved in resource evaluation consulting for 22 years, including resource estimation of nickel laterite deposits for at least five years. I have read the definition of "Qualified Person" set out in NI 43-101 ("the Instrument") and certify that by reason of my education, affiliation with a professional association and past relevant work experience, I fulfil the requirements of a "Qualified Person" for the purposes of the Instrument.
- I visited the Serra do Tapa Project from 6 to 7 August 2019.
- I am responsible for the preparation of the Technical Report. I am independent of the issuer as defined in Section 1.5 of the Instrument.
- I have had no prior involvement with the property that is the subject of the Technical Report.
- I have read the Instrument and Form 43-101F1, and the Technical Report has been prepared in compliance with that instrument and form.
- As of the effective date of this Technical Report, to the best of my knowledge, information and belief, the Technical Report contains all the scientific and technical information that is required to be disclosed to make the Technical Report not misleading.

Dated at Perth, Western Australia, on 31 March 2021,

Original signed

Andrew F. Ross
BSc (Hons), MSc, FAusIMM
Executive Consultant
Snowden Mining Industry Consultants