Density and magnetic properties of komatiite-hosted nickel sulphide deposits: Implications for geophysical exploration

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Introduction

We are increasingly reliant on inversion of geophysical data to identify new exploration targets and develop more robust 3D predictions of subsurface geology.

Prior to performing 3D gravity and magnetic inversion modelling, an understanding of the physical properties of the rocks is required. However, it is not feasible to fully characterise the known geology using measurements of physical properties alone.

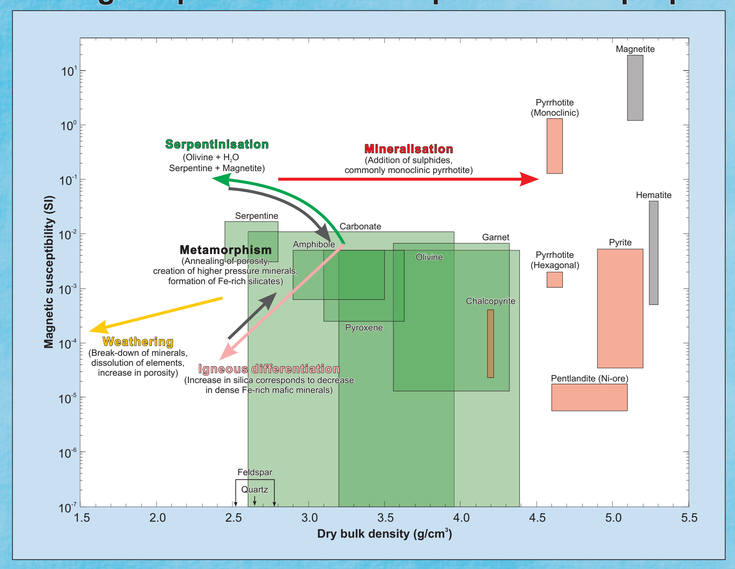
General relationships between the physical properties and the rocks need to be identified. The importance of remanent magnetisation for magnetic interpretation must also be assessed.

These relationships can be used to translate the known geology into constraints for geophysical inversions, and to verify the quality of the recovered inversion models. Only then will predictions of subsurface geology become more reliable.

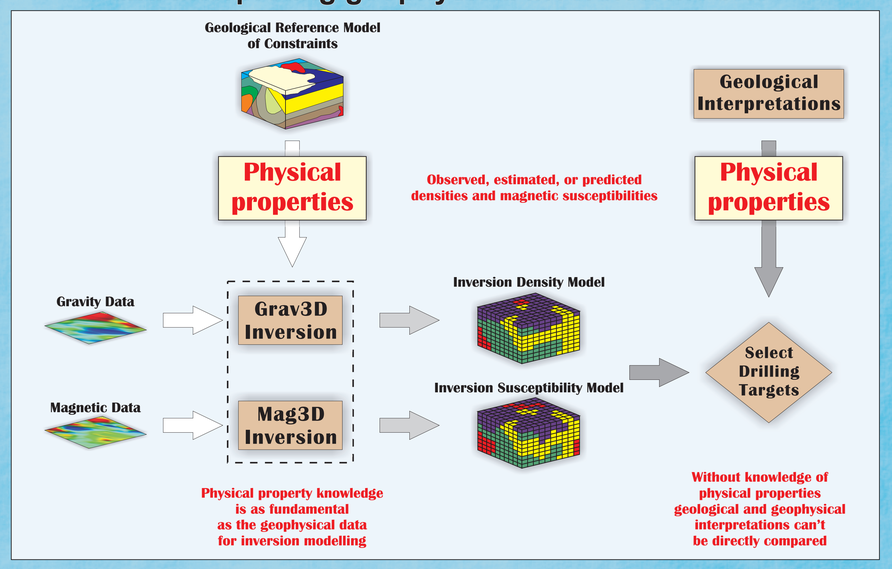
This poster presents an example for Ni exploration around the Perseverance komatiite-hosted nickel sulphide deposit in the Ni-rich Agnew-Wiluna greenstone belt in Western Australia's Archean Yilgarn Craton.

It shows correlations of lab analyses of density and magnetic properties with rock types and various geological processes for 160 surface and drill core samples.

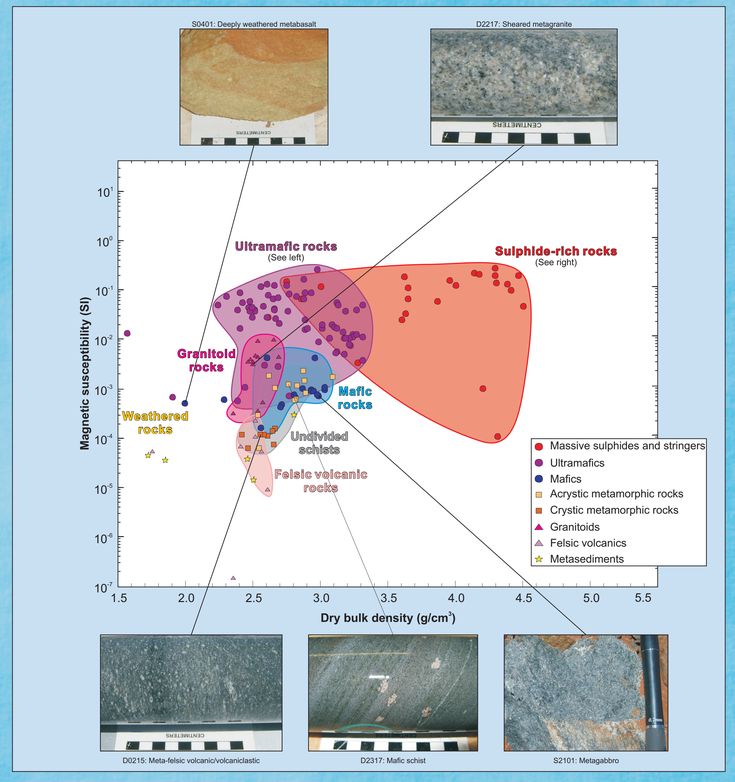
Geological processes control physical properties. Knowledge of processes allows prediction of properties



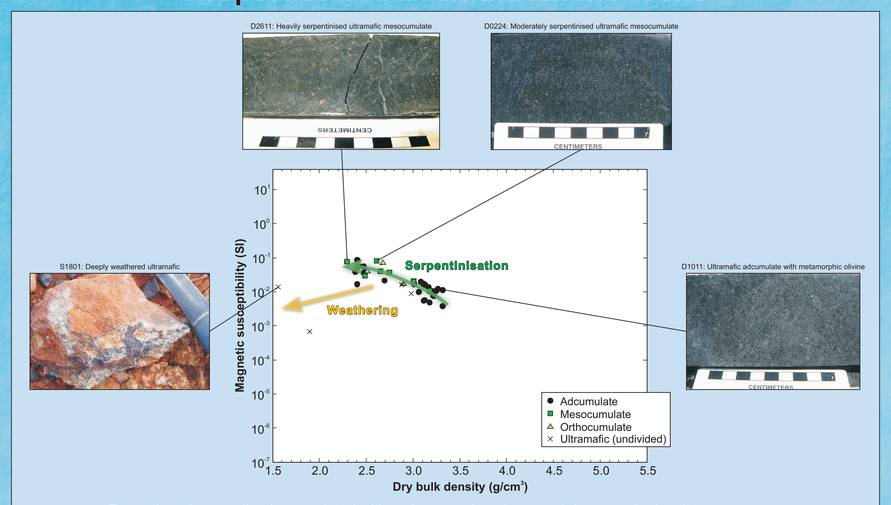
Physical properties are critical for preparing and interpreting geophysical inversion models



Densities and magnetic susceptibilities of rocks in the Perseverance area

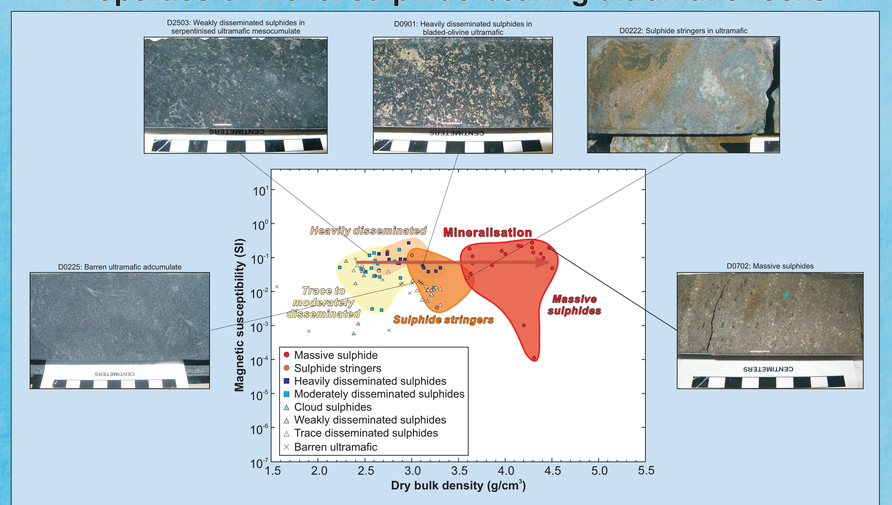


Properties of barren ultramafic rocks



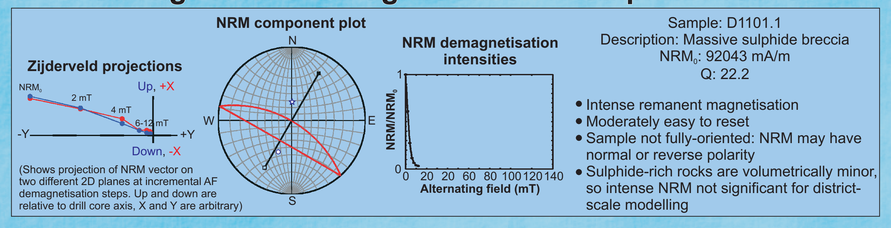
- Formation of serpentine is associated with an increase in volume and decrease in density; formation of magnetite increases susceptibility, but is volumetrically minor so has little effect on density
- Weathering produces clays with a high volume and low density; magnetite is converted into other, less magnetic oxides and hydroxides

Properties of nickel sulphide-bearing ultramafic rocks



- Sulphides primarily include pyrrhotite and pentlandite with lesser pyrite and chalcopyrite
- Addition of sulphides linearly increases the sample densities
- Magnetic susceptibility is controlled by abundance of monoclinic pyrrhotite but for low sulphide abundances the degree of serpentinisation is also important

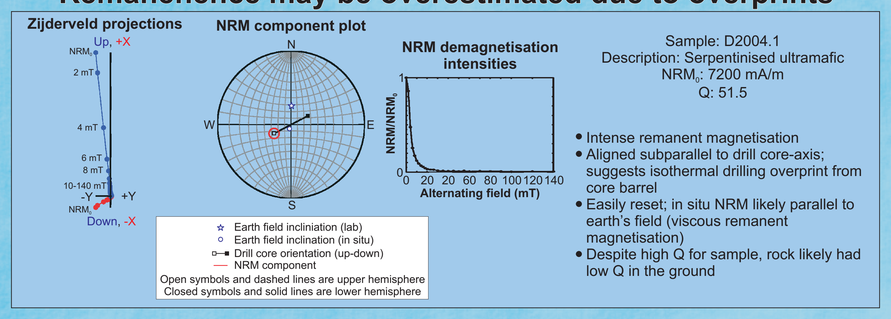
Strong remanent magnetisation in sulphidic rocks



Sample: D1101.1
Description: Massive sulphide breccia
NRM_0: 92043 mA/m
Q: 22.2

- Intense remanent magnetisation
- Moderately easy to reset
- Sample not fully-oriented: NRM may have normal or reverse polarity
- Sulphide-rich rocks are volumetrically minor, so intense NRM not significant for district-scale modelling

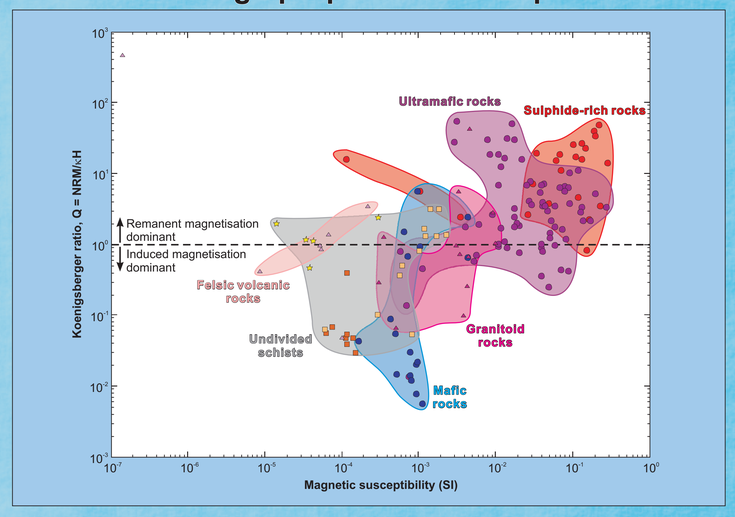
Remanence may be overestimated due to overprints



Sample: D2004.1
Description: Serpentinised ultramafic
NRM_0: 7200 mA/m
Q: 51.5

- Intense remanent magnetisation
- Aligned subparallel to drill core-axis; suggests isothermal drilling overprint from core barrel
- Easily reset; in situ NRM likely parallel to earth's field (viscous remanent magnetisation)
- Despite high Q for sample, rock likely had low Q in the ground

Remanent magnetisation appears dominant in a high proportion of samples



Conclusions

Despite wide ranges in observed density and magnetic properties, distinct trends related to geological processes are present.

Knowledge of rock types and processes may allow superior prediction of physical properties compared to textbook values.

Basic physical property measurements are easy to obtain and increase the value of geophysical data and interpretations.

Remanent magnetisation is important, but basic NRM intensity and Q measurements may not reflect the *in situ* remanent magnetisation due to viscous and drilling overprints. Only demagnetisation can confirm NRM intensities.

Acknowledgments

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