Regional geology and mineral systems of the Stavely region, western Victoria

Data release 1 – Stratigraphic drilling field data

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Executive summary

The Stavely Project is a collaboration between Geoscience Australia and the Geological Survey of Victoria. During 2014 fourteen pre-competitive stratigraphic drill holes were completed in the prospective Stavely region in western Victoria in order to better understand subsurface geology and its potential for a variety of mineral systems. The Stavely region hosts several belts of poorly-exposed Cambrian volcanic and intrusive rocks, visible largely only in magnetic data, which have similarities to those found in modern subduction-related tectonic settings. Mineralisation associated with porphyry Cu-Au and volcanic-hosted massive sulphide mineral systems is known where these rocks are exposed around Mount Stavely and the Black Range. However, despite a history of mineral exploration dating back to the late 1960s, significant economic deposits are yet to be discovered, and the Stavely region remains a greenfields terrane. Given the geological setting and known mineral potential, opportunity exists for the discovery of large mineral systems beneath extensive, but relatively thin, younger cover.

The Stavely Project aims to provide the framework for discovery in the Stavely region primarily through the acquisition and delivery of pre-competitive geoscientific data. This includes the completion of pre-competitive stratigraphic drill holes in order to test regional geological interpretations and recover material for detailed lithological, petrophysical, geochemical and geochronological analysis. The results will assist in understanding the mineral systems potential of the Stavely region under cover.

This report summarises data collected in the field at the drill sites, either during or immediately following drilling, as part of the Stavely Project, and describes the methods and procedures used. Data presented in this release include drill hole collar information, operational metadata and daily drilling reports, drill core photographs, down-hole surveys, down-hole wireline geophysical logging results, down-hole temperature logging results, down-hole AutoSonde™ gamma data, Lab-at-Rig™ X-ray fluorescence data, diamond drill core recovery percentages, and handheld magnetic susceptibility measurements on the drill core.
1 Introduction

1.1 Project Background

Sporadic historical mineral exploration from the 1960s to the 1990s within and around exposed portions of Cambrian volcanic rocks in the Stavely region of western Victoria resulted in the identification of Cu, Au and base metal mineralisation (e.g. Seymon et al., 2009). More recent research undertaken by universities and government has suggested that some of the Cambrian volcanic rocks are fault-slices of a large, mostly-buried continental margin magmatic arc system – the Stavely Arc. The Stavely Arc is named after the Mount Stavely Belt, which hosts Cambrian igneous rocks of arc affinities and includes the Mount Stavely Volcanic Complex (Crawford and Keays, 1978; Buckland, 1987). The Cambrian volcanic and intrusive rocks of the Stavely Arc have potential to host world-class magmatic-hydrothermal ore deposits. The aim of the Stavely Project is to further encourage and support efficient mineral exploration of the Stavely Arc, by better delineating its distribution and internal geological variation, and characterising mineralisation styles and context.

Crawford and Keays (1978) were the first to describe the Cambrian igneous rocks exposed in western Victoria as having a calc-alkaline character, with the mineralogy and geochemistry of the rocks at Mount Stavely, in particular, suggestive of formation in a magmatic arc-style tectonic setting. Since then several workers have drawn comparisons between the exposed Cambrian volcanic rocks of western Victoria and the Mount Read Volcanics of western Tasmania, the latter of which hosts world class volcanic-hosted massive sulphide (VHMS) deposits (Crawford et al., 1996; Crawford et al., 2003). A range of tectonic settings for the origin of the igneous rocks in western Victoria have been proposed, each with implications for regional metallogeny.

In 2009, the Geological Survey of Victoria (GSV), in collaboration with Geoscience Australia (GA) and AuScope, designed and acquired regional-scale deep crustal seismic reflection transects across western Victoria. The project results supported the interpretation of the Cambrian igneous rocks exposed around Mount Stavely, in the Black Range, and in several belts buried beneath younger sedimentary rocks as fault slices of the Stavely Arc, which developed above a west-dipping convergent continental margin during the Cambrian. Seismic reflection data imaged an apparent arc edifice remaining largely intact beneath the Stavely region, the upper parts of which have been thrust to the surface.

The setting was interpreted to have the potential to host significant base metal and precious metal deposits, including porphyry and related mineral systems. In addition, it was recognised that the apparent strike extent of individual volcanic belts continues to the north of known occurrences and that historic mineral exploration had not adequately tested the volcanic rocks under cover. In 2011, the Willaura Project was established by the GSV to evaluate the Cu potential of the southern extent of the Grampians-Stavely Zone in the vicinity of exposed Mount Stavely Volcanic Complex rocks (Cayley et al., in prep. a). In 2013, GA and the GSV initiated the Stavely Project in order to evaluate the mineral potential of the new search space identified below younger cover throughout the Stavely region and build and expand on the key findings of the Willaura Project.

1 The Stavely Arc now replaces the informal and preliminary term ‘Miga Arc’. This term is now abandoned.
The Stavely Project area comprises approximately 20,000 km² (Figure 1.1). It includes at least eight volcanic belts and the Dimboola Igneous Complex, which extends north from Horsham beyond the project area into far north-west Victoria (Figure 1.2). The volcanic belts are separated by wider regions of deformed Cambrian and Ordovician to Silurian sedimentary rocks, intruded by Cambrian and Devonian intrusive rocks, and are also buried by cover rocks of variable thicknesses. The cover rocks include Mesozoic-Cenozoic fill of the Murray and Otway basins and Cenozoic lavas of the Newer Volcanic Group. While a combination of existing exposure, regional geophysics, historical open file drilling, and deep seismic reflection transects has allowed the broad delineation of these volcanic belts under younger cover, the buried parts of the Stavely Arc remain largely untested for their mineral systems potential.

1.2 Geography

The Stavely Project area is located in western Victoria, south-eastern Australia, approximately 230-300 km west and northwest of Melbourne (Figure 1.1). The regional centres of Hamilton and Horsham are located to the south and within the centre of the project area, respectively (Figure 1.3). The project area has generally very low relief, with only exceptions being the Grampians Ranges and Mount Arapiles, which rise above the plains and effectively mark the western end of the Great Dividing Range. North of the divide, the Wimmera River flows past the Grampians National Park and through Horsham towards Lake Hindmarsh. South of the divide, the Glenelg River flows from its origins within the Grampians Ranges, toward the Southern Ocean. In the south of the project area, the Hopkins River flows through Wickliffe and Chatsworth towards the ocean. Many streams in the region are ephemeral and are often dry for long periods. Dryland farming (crops and livestock) comprise large portions of the project area. The Little Desert and Wyperfield national parks border the project area to the north.

1.3 Mineral exploration in the Stavely region

Mineral exploration around the exposed belts of Cambrian volcanic rocks began in 1969 when Western Mining Corporation Limited commenced stream sediment and soil geochemical sampling (e.g. Clappison, 1972). Continued exploration by Duval Mining Limited (formerly Pennzoil) followed up on some of the weak geochemical anomalies in 1975, and had quick success with the discovery of gossanous float containing elevated Cu. Follow-up diamond drilling of anomalies within the Mount Stavely Belt discovered stringer chalcopyrite mineralisation in tuffs, now known as the Wickliffe prospect (Figure 1.4). Diamond drill hole WICKLiffe NO. 6 terminated in hydrothermally-altered quartz porphyry, tentatively correlated with the intrusive Lalkaldarno Porphyry (Ramsay, 1983). Soil geochemistry, geophysics, shallow rotary and deeper diamond drilling was successful in identifying additional mineralised quartz-feldspar porphyries at Junction and Thursdays Gossan (Roberts, 1982; Buckland, 1987; Figure 1.4). Further mineral exploration by subsequent companies in the 1990s discovered several additional occurrences of VHMS and porphyry-style mineralisation, including a Cambrian diorite (now referred to as the Lexington prospect) outside of the Mount Stavely Belt (Figure 1.4).

Northeast of Balmoral, minor placer and hard-rock Au was first discovered in the late nineteenth century, associated with poorly-exposed igneous rocks exposed in valleys which have been eroded through overlying sedimentary rocks of the Grampians Group. These igneous rocks are now included within the Black Range Belt (Figure 1.2). Exploration in the region began in earnest in the late 1960s and several Au and base metal prospects were discovered aligned along the length of the volcanic

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belt. The most promising prospect identified was the McRaes prospect (now referred to as the Eclipse prospect; Figure 1.4) where anomalous Au, Zn, Pb, Cu and Ag is associated with hydrothermally-altered mafic to intermediate volcanic rocks.

A case history study in the late 1990s (Rajagopalan, 1999) detailed Cu-Mo-Au porphyry mineralisation at Mount Stavely and argued that deep weathering had compromised some of the early geochemical exploration and that only the shallow levels of the system had been tested. Although supergene chalcocite mineralisation had been defined at prospects such as Thursdays Gossan, shallow drilling campaigns targeting geochemical anomalies had often failed to penetrate leached in situ regolith and consequently yielded ambiguous results. Limited investigation of the underlying hypogene mineralisation occurred with most drill holes terminating in variable Cu mineralisation associated with hydrothermal alteration. Due to remaining uncertainty over the geological context, exploration of the mineralised systems at depth was not undertaken.

Recent reinterpretation of historic diamond drill core from the early exploration campaigns in the Mount Stavely Belt suggests that porphyry intersections represent dykes that have intruded into the host volcanic rocks, and that large porphyry bodies of potential economic interest may exist at depth and remain untested (Taylor et al., 2014). A similar problem also exists in the Black Range Belt. Here, insufficient drill testing of known mineralisation, as well as geological uncertainty and the presence of barren Silurian-age Grampians Group cover, has impeded mineral exploration across much of the region.

1.4 The Stavely Project

Despite a relatively long history of mineral exploration in the exposed portions of the Cambrian volcanic rocks, the Stavely region remains a greenfields terrane with the opportunity for significant mineral discoveries, especially below younger cover. The Stavely Project was established in order to provide the fundamental framework for the evaluation and discovery of mineral systems in the Stavely region using a mineral systems-based approach. The Stavely Project is a collaborative program between GA and the GSV and forms part of the broader UNCOVER Initiative (Australian Academy of Science, 2012) and the National Mineral Exploration Strategy (COAG, 2012), which seeks to address the challenges of greenfield mineral exploration in areas of Australia under younger cover.

The Stavely Project aims to provide the framework for exploration risk reduction and discovery in the Stavely region through four key objectives:

1. Characterise subsurface geology and recognise favourable geological environments where major mineral systems may have been active;
2. Identify key elements that demonstrate mineral systems potential;
3. Understand the depth and nature of cover; and
4. Deliver new pre-competitive data and concepts for industry, presenting the evidence for mineral systems potential in greenfields areas under cover.

In addition to the compilation and review of historical geoscientific data for the region, the objectives outlined above were addressed through the acquisition of pre-competitive data, including the completion of a stratigraphic drilling program to test regional geological interpretations and recover samples for lithological, petrophysical, geochemical and geochronological analyses. Site-specific geophysical data acquisition tested the thickness and geophysical properties of cover at selected drill positions.
sites (Meixner et al., in prep.). The results of the stratigraphic drilling program will help to better define the margins of the Grampians-Stavely Zone and give further insight into the context, origin and timing of regional mineral systems and aid in future exploration targeting.

Figure 1.1: Location of the Stavely region and structural geological zones of Victoria. Figure adapted from VandenBerg et al. (2000).
Figure 1.2: Known and interpreted volcanic belts of the Stavely Arc. The image is a partially-transparent histogram-equalised pseudocolour layer of the tilt-angle total magnetic intensity (TMI) reduced to the pole (RTP), overlain on a 3-30 km band pass filtered, histogram-equalised pseudocolour layer of TMI (RTP). Blue colours indicate lower magnetic intensity and phase angle values; red colours indicate higher magnetic intensity and phase angle values.
Figure 1.3: Location of the Stavely Project area and significant geographical features.
Figure 1.4: Location of currently known mineral prospects within the Stavely Project area.
2 Geological overview

The Grampians-Stavely Zone (Figure 1.1) lies at the eastern edge of the Cambrian Delamerian Orogen in western Victoria (VandenBerg et al., 2000; Crawford et al., 2003), with the adjacent Stawell Zone forming a complex hybrid transition to the Lachlan Orogen further east (Miller et al., 2005; Cayley et al., 2011; Cayley et al., in prep. b). The interpreted Stavely Arc within the Grampians-Stavely Zone outcrops as a number of narrow north-trending belts of mafic to felsic igneous rocks at Mount Stavely, Mount Dryden, Mount Elliot, and in the Black Range region (Figure 1.2). These were first described during reconnaissance geological mapping of western Victoria in the nineteenth century (Krause, 1873). The belts of igneous rocks are separated by terrigenous deep marine low-grade sedimentary rocks of the Glenthompson Sandstone (Nargoon Group; VandenBerg et al., 2000). A key characteristic of the Cambrian rocks within the Grampians-Stavely Zone is their low (prehnite-pumpellyite facies) metamorphic grade. This contrasts markedly with amphibolite facies metamorphic rocks in the adjacent Glenelg (Gray et al., 2002; Morand et al., 2003) and Stawell (Cayley and Taylor, 2001; Phillips et al., 2002) zones, which lie either side of the region (Figure 1.1).

Early assignment of a Cambrian age for the igneous rocks exposed at Mount Stavely and in the Black Range region was based on comparison with similar rocks in central Victoria from which Cambrian fossils had been recovered (Thomas, 1939). Subsequently, geochronology (Bucher, 1998; Stuart-Smith and Black, 1999; Whelan et al., 2007; Lewis et al., in prep.) has confirmed Cambrian ages ranging from 510 Ma to 500 Ma for parts of the Mount Stavely Volcanic Complex. The other volcanic belts in the region currently remain undated.

In the south of the Stavely Project area, the Stavely Arc comprises five individual, relatively narrow (3-8 km) north-northwest-trending volcanic belts (Figure 1.2), which from east to west have been termed the Mount Dryden (190 km strike length), Mount Elliot (25 km strike length), Mount Stavely (80 km strike length), Bunnugal (65 km strike length), and Boonawah (105 km strike length) belts. The Mount Dryden and Mount Stavely belts are directly linked by an oblique series of sub-parallel west- to northwest-trending, faulted volcanic belts, including the Mount Elliot Belt. The Mount Stavely and Bunnugal belts also converge north of Glenthompson. These volcanic belt linkages suggest formation in a contiguous volcanic arc.

Recent mapping by the GSV has identified a swarm of mafic sills intruding into the Glenthompson Sandstone west of the Mount Stavely Belt. These sills are yet to be described and formalised, but are also considered likely to represent part of the Stavely Arc package. In addition, scattered occurrences of tholeiitic to boninitic lavas also occur throughout the Grampians-Stavely Zone. These may represent igneous rocks related to the ~600 Ma breakup of Rodinia or the later (~520-500 Ma) convergence and deformation associated with the Delamerian Orogeny (Münker and Crawford, 2000; Miller et al., 2005). Rare ultramafic rocks consisting of serpenitised peridotite (e.g. Williamsons Road Serpentinite) also occur in narrow fault slices amongst the other rock packages.

The Stavely Arc, underlying rocks, and overlying Nargoon Group sediments were folded, faulted, and locally tilted to sub-vertical attitudes at around 500 Ma during the Delamerian Orogeny (Crawford et al., 2003). The timing of deformation is constrained by large, post-tectonic, sub-circular intrusions of the Cambrian Bushy Creek Igneous Complex (489 ± 7 Ma; Stuart-Smith and Black, 1999), which intrude deformed Glenthompson Sandstone and truncate the mafic sills west of Mount Stavely.
(Crawford et al., 2003). A number of dacitic porphyries (both barren and mineralised) are known near Mount Stavely and occur both within and external to the volcanic belts (Skladzien et al., 2015). Recent studies suggest that the mineralised porphyry intrusions may share some geochemical affinities with parts of the Bushy Creek Igneous Complex and hence may be associated with the latest pulses of magmatism in the Stavely Arc (Taylor et al., 2014). Recent dating of the mineralised, informally named Victor Porphyry, within the Mount Stavely Belt, yielded an igneous crystallisation age of approximately 500 Ma (Lewis et al., in prep.).

The volcanic belts of the Black Range area lie to the north of the Grampians, including, from east to west, the Glenisla, Black Range and Tyar belts (Figure 1.2). These are typically 2-3 km in width and 18-30 km in strike length. These belts converge in the south beneath a region covered by Early Devonian volcanic rocks (Rocklands Volcanic Group), and are intruded by post-tectonic granite (likely Devonian in age). Further north of the Grampians a highly magnetic package of igneous rocks of unresolved affinity lies entirely under younger cover, including rocks assigned to the Dimboola Igneous Complex (VandenBerg et al., 2000; Crawford et al., 2003; Figure 1.2).

Regional-scale deep seismic reflection data suggest that the Stavely Arc rocks exposed in the Mount Stavely Belt and in the Black Range region overlie a crest of a crustal-scale, triangular-shaped region of variably reflective crust (Cayley et al., in prep. b). This is interpreted to be the buried, but largely intact, remnants of the Stavely Arc, developed on older rocks related to the rifted east Gondwana margin. The volcanics exposed at Mount Stavely, in the Black Range, and at Mount Dryden are all interpreted to be thrust slices of the underlying Stavely Arc system (Cayley et al., in prep. b).

The outcropping Mount Stavely Volcanic Complex in the Mount Stavely Belt (Figure 1.2) comprises interbedded subaqueous tuffaceous and volcaniclastic rocks, and as a whole is interpreted to be overlain by deep marine turbiditic rocks of the Glenthompson Sandstone (Buckland, 1987). The association of the Mount Stavely Volcanic Complex with deep marine sedimentary rocks led to the interpretation of a post-collisional rift sequence erupted subsequent to an arc-continent collision event, akin to the Mount Read Volcanics of western Tasmania (e.g. Crawford, 1988; VandenBerg et al., 2000; Crawford et al., 2003). Other early interpretations of the overall tectonic setting of the Mount Stavely Volcanic Complex envisaged a Gondwanaland continental margin setting (Crawford, 1982). This hypothesis has recently found support in subsequent geochemical (e.g. Kemp, 2003), geochronological (Foden et al., 2006), and crustal geometry (paired metamorphic belts; Miller et al., 2005) studies.

These results led Foden et al. (2006) to question earlier arc-continent collisional models advocated for the Stavely Arc. Foden et al. (2006) instead suggested a west-dipping continent-directed subduction zone. Geophysical (seismic and magnetotelluric) data presented by Cayley et al. (2011; in prep. b) and Robertson et al. (in press) also argue for a convergent continental arc setting above a west-dipping subducting slab. A variant on this interpretation was proposed by Gibson et al. (2011) who argued for initial east-dipping subduction, intra-oceanic arc accretion, and a subsequent flip in subduction polarity resulting in emplacement of the Stavely Arc above a west-dipping continental margin.

The Cambrian rocks are overlain by the Late Ordovician- to Silurian-aged, fluvial to shallow marine siliciclastic rocks of the Grampians Group (Cayley and Taylor, 1997; Miller et al., 2001; Cayley et al., 2011). In some places the contact is unconformable, but in most places the contact is faulted and or sheared, and the Grampians Group sequence contains significant structural complexity in its own right (Cayley and Taylor, 1997; Miller et al., 2001). Although this group is thickest and most structurally complex close to the eastern edge of the Grampians-Stavely Zone, overall the Grampians Group is
much thinner than previously assumed, especially in the regions surrounding the main mountain ranges (Cayley and Taylor, 1997). Silurian deformation associated with the overlying Grampians Group has affected the underlying Cambrian rocks in places (Cayley and Taylor, 1997, 2001; Morand et al., 2003), and has resulted in the truncation, offset and reorientation of fault slices of the Stavely Arc. Using Grampians Group deformation history as a template, the underlying Cambrian rocks can be undeformed to show a simpler pre-Silurian configuration, including restoration of the now fragmented porphyry and alteration systems contained within the volcanic belts.

The Grampians Group and its Cambrian basement are intruded by numerous Late Silurian to Early Devonian felsic intrusives, including the Dwyer Granite, Mirranatwa Granite, Bullawin Porphyry, Mafeking Suite and Duchembegarra Granite (e.g. see VandenBerg et al., 2000). These are comagmatic with the Rocklands Volcanic Group (Simpson, 1997) which lies to the west of the Grampians Ranges.

Since the Devonian, the Grampians-Stavely Zone has remained one of the most tectonically stable parts of Australia (Foster and Gleadow, 1992). The Stavely Arc was buried beneath Nargoon Group sediments in the Cambrian and subsequently by Grampians Group, and has since experienced relatively minimal uplift and erosion. This accounts for the relatively high, upper-crustal level of preservation of much of the Cambrian geological system. It is likewise expected that related mineral systems will also remain preserved.

Today, the Cambrian bedrock of the Grampians-Stavely Zone is poorly exposed. Key areas of outcrop are at Mount Stavely, as a string of isolated hills near Mount Dryden, in the vicinity of Mount Elliot and Yarram Park, and as poor outcrops in the Black Range region west of the Grampians. The main Grampians Ranges and National Park overlies the centre of these outcrops. Further south, aeromagnetic and gravity data allow the Cambrian bedrock and its intermittent veneer of Grampians Group to be traced beneath thin basalt lava flows of the Newer Volcanic Group, and beneath the Otway Basin.

To the north, geophysical and historical drill hole data allow the Cambrian bedrock to be traced north beneath the Murray Basin. The Murray Basin is a Cretaceous to Recent intracratonic sag basin that hosts world-class heavy mineral sand deposits (Olishina and van Kann, 2012), and gradually attains thicknesses of several hundred metres (McLean, 2010). The extremely gentle dip of the Murray Basin means that over 200 km strike-length of the Cambrian bedrock of the Grampians-Stavely Zone lies within 200-300 m of the present-day surface and could be explored using modern mineral exploration techniques.
3 Overview of pre-competitive stratigraphic drilling in the Stavely Project area

Pre-competitive stratigraphic drill holes are a key component to building an understanding of the geology and mineral systems potential of the Stavely region. Fourteen pre-competitive stratigraphic drill holes, for a total of 2708.5 m, were completed in order to test regional geological interpretations, determine the depth and nature of cover, and to recover material for subsequent detailed analysis.

3.1 Drilling objectives

The scientific objectives for the holes drilled as part of the Stavely Project are summarised under five key categories (along with the names of specific drill holes):

1. Test the under cover extent of the Mount Stavely Belt, its stratigraphic facing, and its relationship with overlying sedimentary units (STAVELEY02 and STAVELEY17);

2. Test the presence of interpreted arc-related rocks under cover to define the eastern margin of the Stavely Arc (STAVELEY01 and STAVELEY16);

3. Test regional structural interpretations to define the western margin of the Stavely Arc (STAVELEY05 and STAVELEY08);

4. Test for the presence of rocks belonging to the Stavely Arc which have been imaged by magnetic data and determine their character and stratigraphic affinity (STAVELEY01, STAVELEY02, STAVELEY04, STAVELEY07, STAVELEY11, STAVELEY14), as well as target different levels of stratigraphic exposure in the package of north-northwest-trending magnetic rocks previously interpreted as the Dimboola Igneous Complex (STAVELEY09, STAVELEY10, STAVELEY12, STAVELEY16); and

5. Characterise the nature of geophysical responses in interpreted arc rocks to test for alteration-related demagnetisation (STAVELEY06).

A summary for each drill hole is provided in Table 3.1. The location of the pre-competitive stratigraphic drill holes are provided in Figure 3.1 and Figure 3.2.
Table 3.1: Drill hole collar locations, drilling aims, and associated data collected as part of the Stavely Project.

<table>
<thead>
<tr>
<th>Hole ID</th>
<th>Drilling type</th>
<th>Latitude (GDA94)</th>
<th>Longitude (GDA94)</th>
<th>Target</th>
<th>Total depth (m)</th>
<th>Down-hole geophysics</th>
<th>Temp. logging</th>
<th>Lab-at-Rig™</th>
<th>AutoSonde™</th>
</tr>
</thead>
<tbody>
<tr>
<td>STAVELY01</td>
<td>Diamond</td>
<td>-38.018</td>
<td>142.878</td>
<td>Possible Mount Stavely Volcanic Complex or Mount Dryden Volcanics equivalent.</td>
<td>249.5</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY02</td>
<td>Diamond</td>
<td>-37.902</td>
<td>142.712</td>
<td>Extension of the Mount Stavely Belt beneath Grampians Group cover.</td>
<td>159.5</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY03</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Demagnetised zone within an otherwise magnetic belt of interpreted Cambrian volcanic rocks.</td>
<td>Hole cancelled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAVELY04</td>
<td>Sonic, diamond</td>
<td>-37.164</td>
<td>142.251</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks.</td>
<td>102.8</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY05</td>
<td>Sonic, diamond</td>
<td>-37.097</td>
<td>142.016</td>
<td>Test for the presence of high-grade metamorphic rocks of the Glenelg Zone to validate structural interpretations.</td>
<td>71.5</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY06</td>
<td>Sonic, diamond</td>
<td>-37.050</td>
<td>142.274</td>
<td>Demagnetised zone within an interpreted intrusive rock.</td>
<td>117.7</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>STAVELY07</td>
<td>Sonic, diamond</td>
<td>-36.994</td>
<td>142.323</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks. Extended to depth to serve as a paleoclimate monitoring bore for the University of Melbourne.</td>
<td>501.6</td>
<td>No</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY08</td>
<td>Sonic, diamond</td>
<td>-36.910</td>
<td>141.670</td>
<td>Test for the presence of high-grade metamorphic rocks of the Glenelg Zone to validate structural interpretations.</td>
<td>122.0</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>STAVELY09</td>
<td>Sonic, diamond</td>
<td>-36.800</td>
<td>142.159</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks and to test the lower stratigraphic levels of a north-northwest-trending package of rocks previously interpreted as Dimboola Igneous Complex.</td>
<td>165.6</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY10</td>
<td>Sonic, diamond</td>
<td>-36.804</td>
<td>142.130</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks and to test the lowest stratigraphic level of a north-northwest-trending package of rocks previously interpreted as Dimboola Igneous Complex.</td>
<td>107.4</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY11</td>
<td>Sonic, diamond</td>
<td>-36.767</td>
<td>141.967</td>
<td>Test a weak linear magnetic feature for the presence of a northern extension to the Black Range Belt.</td>
<td>164.6</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Hole ID</td>
<td>Drilling type</td>
<td>Latitude (GDA94)</td>
<td>Longitude (GDA94)</td>
<td>Target</td>
<td>Total depth (m)</td>
<td>Down-hole geophysics</td>
<td>Temp. logging</td>
<td>Lab-at-Rig™</td>
<td>AutoSonde™</td>
</tr>
<tr>
<td>---------</td>
<td>----------------</td>
<td>------------------</td>
<td>------------------</td>
<td>--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------</td>
<td>-----------------</td>
<td>---------------------</td>
<td>--------------</td>
<td>--------------</td>
<td>------------</td>
</tr>
<tr>
<td>STAVELY12</td>
<td>Sonic, diamond</td>
<td>-36.709</td>
<td>142.153</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks and to test the upper stratigraphic levels of a north-northwest-trending package of rocks previously interpreted as Dimboola Igneous Complex.</td>
<td>180.5</td>
<td>Yes</td>
<td>Yes</td>
<td>Test basis only (data not available)</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY13</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Test an elongate magnetic feature to determine its character and stratigraphic affinity.</td>
<td>Hole cancelled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAVELY14</td>
<td>Sonic, diamond</td>
<td>-36.437</td>
<td>141.655</td>
<td>Test a gravity feature for the presence of Cambrian volcanic rocks.</td>
<td>339.0</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>STAVELY15</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks and to test the upper stratigraphic levels of a north-northwest-trending package of rocks previously interpreted as Dimboola Igneous Complex.</td>
<td>Hole cancelled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAVELY16</td>
<td>Sonic, diamond</td>
<td>-36.265</td>
<td>141.921</td>
<td>Magnetic package of rocks interpreted as Cambrian volcanic rocks and to test the upper stratigraphic levels of a north-northwest-trending package of rocks previously interpreted as Dimboola Igneous Complex.</td>
<td>357.7</td>
<td>Yes</td>
<td>Yes</td>
<td>No</td>
<td>No</td>
</tr>
<tr>
<td>STAVELY17</td>
<td>Diamond</td>
<td>-37.683</td>
<td>142.641</td>
<td>Intersect the contact between the Glenthompson Sandstone and the Mount Stavely Volcanic Complex in the Mount Stavely Belt to determine nature of contact and stratigraphic facing.</td>
<td>156.0</td>
<td>Yes</td>
<td>No</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>STAVELY18</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Intersect the contact between the Glenthompson Sandstone and the Mount Stavely Volcanic Complex in the Mount Stavely Belt to determine nature of contact and stratigraphic facing.</td>
<td>Hole cancelled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>STAVELY19</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Hole cancelled</td>
<td>Locate fresh volcaniclastic Glenthompson Sandstone equivalent at-depth for geochronological and geochemical analysis.</td>
<td>Hole cancelled</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
Figure 3.1: Location of drill holes drilled as part of the Stavely Project shown on a background of reduced to pole total magnetic intensity, where red is high and blue is low.
Figure 3.2: Location of drill holes drilled as part of the Stavely Project shown on a background of Bouguer anomaly gravity image where red is high and blue is low.
4 Data release 1 – stratigraphic drilling field data

This report summarises data collected in the field, either during or immediately following drilling, as part of the Stavely Project, and describes the methods and procedures used. Future data releases will subsequently be released as data become available. The datasets are available digitally from GA and the GSV at www.ga.gov.au and also via www.energyandresources.vic.gov.au.

4.1 Drilling techniques

Pre-competitive stratigraphic drilling as part of the Stavely Project had the aim of maximising core recovery, including through unconsolidated cover. This allowed key stratigraphic relationships to be observed, sampling for detailed analysis (e.g. geochemistry, geochronology), potential distal footprints of mineral systems to be recognised, and for benchmarking of geophysical interpretations by preserving material to enable identification of the sources of geophysical signals.

In order to ensure maximum core recovery, sonic and diamond drilling techniques were used. In general, drilling of sonic pre-collars was used where unconsolidated Murray Basin sediments overlay basement rocks, while diamond drilling was used in order to complete basement tails (typically ~30-50 m length). Diamond drilling was used solely where bedrock (including Newer Volcanic Group basalt) outcropped near the surface. An Australian Mud Company (AMC) solids removal unit (SRU) was used for both sonic and diamond drilling to remove solids from the drilling fluid. Water used during drilling was mostly trucked in, although some was sourced from private dams with consent from the relevant landholders. Project management of the drilling program was undertaken by the Deep Exploration Technologies Cooperative Research Centre (DET CRC), who engaged Boart Longyear as the drilling contractor.

Land access negotiations were undertaken by CNC Project Management, with landholder access permission confirmed for drilling activities at all sites by early April 2014. Sonic and diamond drilling took place between 21 April and 16 September 2014. A range of geophysical surveys were undertaken before drilling at each planned drill collar in order to both test and compare methods for estimating depth to basement, and for refining drill hole siting. Details of these surveys are provided in Meixner et al. (in prep.). Planned drill hole azimuths were relative to true north, and the drill rig was aligned on-site accordingly.

4.1.1 Sonic drilling

Sonic pre-collars were completed for eleven drill holes. Of these, one drill hole (STAVELY08) was terminated following sonic drilling as it intersected basement rocks which provided the necessary geological information. In most cases sonic pre-collars were drilled to refusal, which was typically in saprolitic material. Sonic drilling was undertaken using a Boart Longyear LS600T drill rig on a single shift basis. Sonic drilling generally employed a six inch sonic coring system over-ridden with eight inch outer casing. STAVELY14 and STAVELY16, which were drilled into deep Murray Basin sediments, were finished using a 4.75 inch sonic coring system. Sonic drilling employed vertical (-90 degrees) inclinations. Sonic drilling was used on STAVELY04, STAVELY05, STAVELY06, STAVELY07, STAVELY08, STAVELY09, STAVELY10, STAVELY11, STAVELY12, STAVELY14 and STAVELY16, for a total of 1152.3 m. Core recovery was excellent, with greater than 99% recovery. Drilling rates were variable, but averaged 15.2 m per shift throughout the program for sonic drilling.
4.1.2 Diamond drilling

Diamond drilling was undertaken at 13 drill holes. Ten drill holes had diamond tails completed following sonic pre-collaring (STAVELY04, STAVELY05, STAVELY06, STAVELY07, STAVELY09, STAVELY10, STAVELY11, STAVELY12, STAVELY14, STAVELY16) while three drill holes employed diamond drilling from surface (STAVELY01, STAVELY02, STAVELY17). A total of 1556.2 m of diamond drilling was completed, which included 406 m funded by the University of Melbourne in order to establish a paleoclimate observatory at STAVELY07. Diamond drilling was undertaken using a Boart Longyear UDR650 drill rig on a single shift basis. Coring was typically triple tube HQ3, with 406.0 m of triple tube NQ3 completed at STAVELY07. The majority of diamond drill holes were completed at near-vertical inclinations (-80 to -90 degrees), with only STAVELY17 having a significant inclination (-50 degrees). Where possible, all diamond drill core was oriented after each run using a REFLEX ACT HQ or NQ tool, which allowed orientation of very steep drill holes. All diamond drill holes were terminated following achievement of the geological target. As with sonic drilling, average metres drilled per shift was highly variable owing to geological complexities. An average of 12.5 m per shift was achieved throughout the program for diamond drilling. Similarly, diamond core recovery was variable depending on site conditions, but averaged 93% for the program.

4.1.2.1 Data acquisition during diamond drilling

4.1.2.1.1 Lab-at-Rig™ and AutoSonde™

A range of down-hole data were acquired during, or immediately following, diamond drilling. These included Lab-at-Rig™ and AutoSonde™ technologies deployed by the DET CRC. Lab-at-Rig™ was used to analyse depth-controlled drilling solids recovered from the SRU during drilling using both portable X-ray fluorescence (XRF) and X-ray diffraction (XRD; not presented in this release) to provide geochemical and mineralogical information respectively. Lab-at-Rig™ samples were analysed using one metre interval composites. Lab-at-Rig™ was deployed at STAVELY01, STAVELY02, STAVELY04, STAVELY05, STAVELY07, STAVELY09, STAVELY10, STAVELY11, STAVELY12 (test basis only; data not available) and STAVELY17.

DET CRC AutoSonde™ technology was field-trialed on selected holes (STAVELY01, STAVELY02, STAVELY04, STAVELY05, STAVELY07, STAVELY09, STAVELY10, STAVELY11, STAVELY12 and STAVELY17) during the drilling program using a prototype AutoSonde™ Total Count Gamma Logging Tool. The AutoSonde™, developed by DET CRC participants Globaltech Corporation and Curtin University, provides geophysical logging information similar to that recorded by conventional wireline logging, but with significant reductions in costs, inconvenience and risk involved. The AutoSonde™ was lowered inside the drill rods to protrude from the end of the rods on completion of drilling, and the hole was geophysically logged while the rods were being withdrawn from the hole. This had the benefit of reducing the risk for geophysical logging due to hole collapse prior to or during withdrawal of the drill string.

4.1.2.1.2 Down-hole surveys

Multi-shot down-hole surveys were conducted every six metres to determine underground orientation of each drill hole using a REFLEX EZ-TRAC tool, with the exception of STAVELY08 (diamond tail not drilled) and STAVELY12 (single-shot surveys only). In addition, single-shot surveys were also undertaken during drilling at most holes in order to check for any deviation. Single-shot survey frequency was variable, ranging from 15 m to 50 m. Metal casing was left in some holes and consequently corrupted some of the down-hole survey measurements.
4.1.2.1.3 Down-hole temperature measurements

Measurement of down-hole temperature took place in November 2014, eight weeks after completion of drilling, which allowed sufficient time for thermal re-equilibration following drilling. Precision temperature logging was performed by the GSV on STAVELEY01, STAVELEY04, STAVELEY06, STAVELEY09, STAVELEY11, STAVELEY12, STAVELEY14 and STAVELEY16. Drill holes STAVELEY02 and STAVELEY17 were considered unsuitable for temperature logging due to geological factors. Drill hole STAVELEY07 was subject to paleoclimate test work by the University of Melbourne and could not be logged for down-hole temperature because of test equipment which had already been placed in the hole. Measurements were performed using a high-sensitivity thermistor probe assembled by Monex Pty Ltd at Monash University which measures temperature-dependent resistance and converts to temperature using the Steinhart-Hart equation. Temperature measurement accuracies are typically ±0.001 °C, although temperature measurements were variable whilst the probe was above the water table (usually the first 10-30 m). Measurements stabilised upon entering the groundwater whereupon the temperature typically increased at the rate of the geothermal gradient (usually about 0.02-0.03 °C/m). In several cases, obstructions and/or jamming prevented the probe from reaching the bottom of the drill hole.

4.1.2.1.4 Down-hole geophysics

Down-hole geophysical logging was undertaken by Wireline Services Group for all holes, with the exception of STAVELEY07, for magnetic susceptibility, gamma density, induction conductivity, natural gamma and spectral gamma, as well as temperature on a subset of holes (Table 3.1). Down-hole geophysical logging took place in November to December 2014.

4.2 Field sample management and handling

4.2.1 Sonic drill core

Sonic drill core was extracted in core runs of between two and nine metres. The sonic drill core was extruded from the sonic core barrel into plastic sleeves in lengths of approximately 0.5-1.0 m. From these, a small sample of material was taken for geological logging and a reference sample from each plastic sleeve was placed in a plastic chip tray for future reference. Where water-saturated units were encountered, three to five 250 mL jars of material were taken, and immediately placed into onsite refrigeration, for later pore fluid extraction and analysis. The sonic core was transported to the operations base where it was placed in metal core trays where the plastic sleeve was sliced away. The sonic core was then split and the excess was scraped away level with the height of the core tray to expose the internal texture of the core. From the excess material, a minimum of one 250 mL jar of sample was retained from each tray for detailed analysis. The sonic core was then photographed and left to air-dry for several months in open core trays prior to HyLogger™ scanning at the Geological Survey of South Australia’s facility in Adelaide.

2 Down-hole temperature data for STAVELEY07 arising from University of Melbourne research are the property of the University of Melbourne and are not included in this release.
4.2.1.1 Measurement of down-hole depths of sonic drill core

Sonic drill core is susceptible to expansion once extracted from the drill hole. This is particularly the case for clays, which may swell upon depressurisation. As such, measured down-hole depths in many cases exceeded actual drilled depths. Adjusted true depths were achieved by applying a correction factor to the measured depth. The correction factor was calculated by dividing the actual core run length by the measured core run length. For example, a core run of 2.0 m with a measured length of 3.03 m would result in a correction factor of 0.66. A plastic sleeve recovered from this run with a measured length of 0.92 m would result in a corrected length of 0.61 m. All sonic drill core trays were only labelled with adjusted true depths.

4.2.2 Diamond drill core

Diamond drill core was placed into core trays by the drilling contractor on-site. For each drill hole the resulting core was organised in the core tray from bottom to top, right to left, rather than the conventional bottom to top left to right. Black plastic CoreSafe® trays were selected for use due to their low, consistent spectral response, which is optimal for HyLogger™ scanning. The diamond drill core was transported from the drill rig to the base of operations where it was washed and laid out on racks for logging. Each core tray was labelled with the drill hole number, start and end depths, and arrows indicating down-hole direction. Down-hole depths were measured using the driller’s core blocks as a reference and each metre was marked on the core tray and the core. Two continuous parallel lines were then ruled in order to enable the core to be placed back into its original location if removed.

Following markup of the drill core geological logging and recovery measurements were undertaken and recorded manually and subsequently digitally transcribed. Magnetic susceptibility measurements were taken every metre using a handheld Fugro RT-1 magnetic susceptibility meter. These data were used in the field to detect relative shifts in magnetic susceptibility to assist in geological logging. After logging, wet and dry photographs were taken of the drill core and the trays were packed on pallets for transportation. The diamond core was subsequently scanned at the Geological Survey of South Australia’s HyLogger™ facility in Adelaide.

4.2.3 Positional surveying of collars

Following drilling, drill hole collars were surveyed using GA’s Altus APS3 GNSS equipment in June and November 2014. Victoria’s GPSNET Continuously Operated Reference Station (CORS) network provided Real-Time Kinematic (RTK) corrections where reliable mobile telephone coverage existed. In the absence of reliable coverage, static observations of at least several hours duration were made and the raw data (Rinex format) were post-processed with GA’s AUSPOS service. Positional accuracies (X, Y and Z) of better than 50 mm (at the time of measurement) were obtained for all collars.

4.3 Hole casing and decommissioning

Following the drilling of sonic pre-collars, the holes were installed with 150 mm PVC casing to maintain drill hole stability until the completion of diamond tail drilling. Drill holes were cased with 80 mm PVC following diamond drilling. All drill holes were cased to refusal and, with the exception of STAVELEY14 and STAVELY16, encompassed the entire interval of unconsolidated Murray Basin sediments. Eighty millimetre PVC casing was installed through the larger 150 mm sonic drill hole casing where sonic pre-collars were drilled.
The annular space between 150 mm sonic casing and 80 mm diamond casing was sealed prior to wireline logging in November 2014. A deck plug manufactured from bubble wrap was installed at two metres depth using a pole. Following this, one 750 g tin of high-expansion urethane foam was discharged, through a two metre length of 13 mm plastic irrigation tube, to fill the space from the bottom up to avoid air inclusions. The foam generally rose to within 100-200 mm of the top of the casing. The 80 mm casing was centralised to allow room for installation of an end cap.

All holes were closed in late December 2014. The casing was cut down to a minimum depth of 500 mm below surface. A bubble wrap deck plug was inserted two metres below the top of the 80 mm casing then filled with high-expansion urethane foam as previously described. When full, an 80 mm cap was glued on with solvent cement. The remaining space was the filled with non-shrink structural grout for increased mechanical protection. Finally, a 150 mm cap was glued in place in the outer casing if present. The collar of the drill hole was backfilled with soil and mounded to allow for compaction. Any remaining visible drilling-related rubbish (e.g. cable ties, ear plugs, duct tape, pegs, flagging tape) was removed.

All drill holes were decommissioned in accordance with the Victorian Code of Practice for Mineral Exploration and Guidelines for Abandonment of Mineral Drillholes following consultation and approval by the Victorian Department of Economic Development, Jobs, Transport and Resources.
5 Data included in this release

Data included in this release are outlined below. Specific file names are given in bold. Drill holes are referred to as STAVELYnn, where ‘nn’ corresponds to the drill hole number (e.g. STAVELY06).

5.1 Operational information

Operational information is contained within Stavely_Operations.zip. This folder contains the following files:

- Drilling production summary (STAVELY_Drilling_Production_Summary.xlsx): table of metres drilled per day at each site in Microsoft Excel 2010 (.xlsx) format.


5.2 Regional maps

Regional reference maps are contained within Stavely_regional_maps.zip. This folder contains regional overview maps (suitable for printing at an A0 paper size) of the Stavely Project area in Portable Document Format (.pdf). Included within this folder are maps of geophysical imagery (Bouguer gravity, ternary radiometrics, total magnetic intensity reduced to the pole), digital terrain model (DTM), 250k surface geology, and topographic map background. Each map shows final drill hole locations.

5.3 Data acquired from drill sites and drill core

An index of data available for individual drill holes is given in the field reports index (STAVELY field reports index 1.0.xlsx).

Data and information for several data types have been combined into single comma-separated values (.csv) files in order to facilitate incorporation into databases and software packages. These data are contained within Combined_files.zip and include:

- Drill hole collar information (STAVELY_COMPILED_Collar.csv): drill hole collar information, including positional information, drill hole type, depths and casing used. Planned drill hole azimuths are relative to true north. Note that for DrillholeType DD = diamond drill hole, SC = sonic drill hole, and SD = sonic drill hole with diamond tail.

- Drill hole specifications (STAVELY_COMPILED_DH_Spec.csv): containing information on drilling types used at individual drill holes, together with corresponding depths and dates.

- DET CRC Lab-at-Rig™ XRF data (STAVELY_COMPILED_DET_CRC_LAR_XRF.csv): DET CRC deployed a trailer-mounted, manually-operated concept Lab-at-Rig™ which was field-trialled on selected holes (STAVELY01, STAVELY02, STAVELY04, STAVELY05, STAVELY07, STAVELY09, STAVELY10, STAVELY11 and STAVELY17). Data is presented based on downloaded data from...
the ReflexHUB. Data are presented for a suite of elements analysed using XRF, in parts per million, along with depth interval and HoleID. Data for pure SiO\textsubscript{2} powder analytical blanks (BLK), standards (STD) and duplicates (DUP) are also given. Certificates for certified reference materials used as standards are available from [http://www.ore.com.au/oreas-crms](http://www.ore.com.au/oreas-crms).

- Down-hole surveys ([STAVELY\_COMPILED\_Downhole\_Survey.csv](#)): digital down-hole surveying logs containing all measurements from the REFLEX EZ-TRAC survey tool. See Appendix 1 for tool specifications. Data are presented as exported from the survey tool. Note that no down-hole surveys exist for STAVELY08.

- Diamond drilling geotechnical logs ([STAVELY\_COMPILED\_Geotechnical\_Logs.csv](#)): percentage diamond core recovery as logged by the geologists on-site.

- Down-hole temperature logs ([STAVELY\_COMPILED\_GSV\_Downhole\_Temperature.csv](#)): precision temperature logging undertaken by GSV.

- Handheld magnetic susceptibility measurements ([STAVELY\_COMPILED\_Handheld\_Magnetic\_Susceptibility.csv](#)): handheld magnetic susceptibility measurements were undertaken with a Fugro RT-1 meter (see Appendix 2) at nominal one metre intervals on the recovered diamond drill core laid in non-magnetic plastic core trays. Measurements on sonic core were also done with a Fugro RT-1 meter on nominal one metre sub-samples of the core in plastic jars. Data are presented with the raw value (SI x 10\textsuperscript{-5}), core size (DrillType), correction factor applied to raw values, and corrected magnetic susceptibility (SI x 10\textsuperscript{-5}). The correction factor is dependent on the core size (PQ = 1.24, HQ = 1.44, NQ = 1.51, as given in the Fugro RT-1 Magnetic Susceptibility Meter User Manual). Sonic drill core has not had a correction factor applied since measurements were taken of sub-sampled material, and hence are qualitative and indicative only.

The remaining data are organised in folders according to drill hole identity. These are STAVELY01.zip, STAVELY02.zip, STAVELY04.zip, STAVELY05.zip, STAVELY06.zip, STAVELY07.zip, STAVELY08.zip, STAVELY09.zip, STAVELY10.zip, STAVELY11.zip, STAVELY12.zip, STAVELY14.zip, STAVELY16.zip, and STAVELY17.zip. Within these folders, the following information and data are contained:

- Drill hole location map ([STAVELYnn\_Location\_Map.pdf](#)): drill hole location map produced by the GSV in Portable Document Format (.pdf) showing airphoto image with overlaid surveyed drill hole collar, cadastral boundaries and locality plan for each occupied site.

- Drill hole metadata ([STAVELYnn\_Drillhole\_Metadata.xlsx](#)): drill hole metadata in Microsoft Excel 2010 (.xlsx) format containing all relevant operational information relating to the drill hole including drilling dates, location information, hole size and depths, drilling consumables used and down-hole surveys undertaken. See Appendix 3 for specification sheets of drilling fluids used.

- Daily drilling reports ([STAVELYnn\_BL\_Daily\_Reports.pdf](#)): drilling contractor (Boart Longyear; abbreviated to BL) client daily drilling reports in Portable Document Format (.pdf) for sonic and diamond drilling operations.

- Sonic drill core images. Note that only dry drill core photos were taken for sonic drill core. Refer to the field reports index for availability of data for individual holes.  
  - [STAVELYnn\_Sonic\_Drilling\_Core.pdf](#): sonic drill core photo compilation in Portable Document Format (.pdf) with core tray index containing photo file IDs, tray IDs, depth range and individual images with depth interval annotation.
STAVELYnn_Sonic_Drilling_Core_Photos.zip: zip folder containing sonic drill core photos in Joint Photographic Experts Group (.jpg) format. Photos are of each individual core trays of prepared halved sonic core and annotated with true (corrected) depth intervals.

- Diamond drill core images. In most cases, both dry and wet drill core photos were taken for diamond drill core. Refer to the field reports index for availability of data for individual holes.
  - STAVELYnn_Diamond_Drilling_Core.pdf: dry diamond drill core photo compilation in Portable Document Format (.pdf) with core tray index containing photo file IDs, tray IDs, depth range and individual images with depth interval annotation.
  - STAVELYnn_Diamond_Drilling_DRY_Core_Photos.zip: zip folder containing dry diamond drill core photos in Joint Photographic Experts Group (.jpg) format. Photos are of each individual core tray with dry PQ3, HQ3 or NQ3 diamond core and annotated with depth intervals.
  - STAVELYnn_Diamond_Drilling_WET_Core_Photos.zip: zip folder containing wet diamond drill core photos in Joint Photographic Experts Group (.jpg) format. Photos are of each individual core tray with dry PQ3, HQ3 or NQ3 diamond core and annotated with depth intervals.

- DET CRC AutoSonde™ gamma: depth-corrected and un-calibrated gamma counts-per-second plots for STAVELY01, STAVELY02, STAVELY04, STAVELY05, STAVELY07, STAVELY09, STAVELY10, STAVELY11, STAVELY12 and STAVELY17 are presented as:
  - Portable Document Format (.pdf; STAVELYnn_DET_CRC_AutoSonde_Logs.pdf), and
  - ASCII *.LAS files (STAVELYnn_DET_CRC_AutoSonde.LAS), which can be opened using a standard text editor.

- Down-hole wireline geophysical logs: geophysical properties acquired include natural gamma, induction conductivity, resistivity, gamma density, magnetic susceptibility, temperature (in selected drill holes) and spectral gamma. See Appendix 4 for down-hole tool calibration and specification sheets. Both filtered and unfiltered files are given, as supplied by the contractor. In cases where PVC casing had been joined with steel screws at six metre intervals, magnetic susceptibility data has been despiked to remove the effect of the screws. Both Portable Document Format (.pdf) ASCII *.LAS files and are provided:
  - STAVELYnn_GA_WirelineLogs_Filtered_1cm.LAS: filtered wireline logs for natural gamma, induction conductivity, resistivity, gamma density, magnetic susceptibility, and temperature (in selected drill holes).
  - STAVELYnn_GA_WirelineLogs_Filtered_1cm_Despiked.LAS: filtered wireline logs for natural gamma, induction conductivity, resistivity, gamma density, magnetic susceptibility, and temperature (in selected drill holes). Spikes in magnetic susceptibility due to screwed casing have been manually removed.
  - STAVELYnn_GA_WirelineLogs_NonFiltered_1cm.LAS: unfiltered wireline logs for natural gamma, induction conductivity, resistivity, gamma density, magnetic susceptibility, and temperature (in selected drill holes).
  - STAVELYnn_GA_WirelineLogs_NonFiltered_1cm_Despiked.LAS: unfiltered wireline logs for natural gamma, induction conductivity, resistivity, gamma density, magnetic susceptibility, and temperature (in selected drill holes). Spikes in magnetic susceptibility due to screwed casing have been manually removed.
  - STAVELYnn_Spectral.LAS: spectral gamma wireline logs in ASCII *.LAS format.
6 Appendices

The following appendices are included in this release:


**Appendix 4**: down-hole geophysical logging tool calibration and specification sheets.
Acknowledgements

Tim Barton was instrumental in compiling and organising the data associated with this report. Drill hole collars were surveyed by Malcolm Nicoll and Tony Meixner, who also assisted in drill hole decommissioning. Ian Roach and Marina Costelloe assisted with acquisition of down-hole geophysical logging. Drill core recovery percentages were tabulated by Sarlae McAlpine. Down-hole temperature data acquired by the Geological Survey of Victoria was supplied by David Taylor. Christian Thun and the staff from the palaeontology and sedimentology laboratory at Geoscience Australia oversaw the enormous task of preparing, labelling and photographing the sonic drill core. David Higgins and Phil Skladzien prepared thematic maps for the project area. Ian Roach and David Champion are thanked for their thoughtful reviews of this document, and Cameron Cairns and Rob Duncan are thanked for QA/QC of the associated data.
References


Clappison, R.J.S. 1972. (A) Stavely Area, Victoria, Late E.L. 133 and (B) Black Range Area, Victoria, Late E.L. 134. Western Mining Corporation Limited Report No K/1771. Victorian Geological Survey (Reference ID 31100).


