Exploration targets in the Wandie Granite area.

J. Stockfeld, July 2013

Preamble

The Wandie Granite area has been identified as a new exploration target with the potential to host Au ± PGE mineralisation within the metamorphic aureole of the granite. Mineral deposits of this style are well documented in the Pine Creek Orogen (PCO) with Coronation Hill being foremost among them. Less well known are the gold occurrences that bear strong similarities to Tennant Creek style mineralisation, these being as yet undocumented in the PCO. It turns out that these two styles of mineralisation can be understood as variants of the same thing,[1] and understanding the reasons for this could potentially yield clear vectors in exploration targeting using a model hitherto untried in the PCO. Several features in the Wandie Granite area present conceptual targets that conform to this model.

The role of the granites in gold mineralisation

Klominsky's 1996 study of the granites[2] of the Cullen Batholith is the basis for a significant advance in understanding the mechanisms of gold mineralisation in the PCO, providing for a model that explains far more than those deployed by Dominion Mining and its successors. While previous exploration strategies had largely adhered to the model for Thermal Aureole Gold (TAG) mineralisation and had thus understood the mineralising events to be contemporaneous with granite emplacement,[3] a new strategy is based on the idea that mineralisation is associated with amagmatic hydrothermal systems and therefore significantly post-dates granite emplacement.[4] The new model incorporates both Coronation Hill and Tennant Creek styles of mineralisation where the TAG model could accommodate neither.

The amagmatic model for gold mineralisation is based on the idea that the hydrothermal system is a low-temperature phenomenon which post-dates granite emplacement and is driven by radioactive decay within the granite.[5] The Cullen Batholith is noted for its high radiothermal content, having twice the average granite heat production overall. The individual granite plutons vary according to their radiothermal content and Klominsky classifies them on this basis, with each being assigned a heat production value measured in microwatts per cubic metre ($\mu W/m^3$).

Klominsky subdivides the granites of the Cullen Batholith into three igneous suites defined according to their intrusive age, with the youngest of these, the Young Igneous Suite (YIS), being the one associated with the gold mineralisation.[6] The average heat production value of the YIS is significant, being up to 10 $\mu W/m^3$ which is four times the average granite heat production and thus double the average value for the Batholith overall.

Young granites with an unusually high heat production value are the ones associated with gold mineralisation and Burnside is the standout example. Yinberrie, Wolfram Hill and

[1] Wall and Valenta, 1990
[2] Klominsky et al, 1996.
[3] Matthai et al, 1995.
[4] McLaren et al, 1999
[5] McLaren et at 1999; Partington and McNaughton, 1997
[6] Partington and McNaughton, 1997

Wandie also belong to the YIS. Among these, Wandie is the one with the highest heat production value, being in the highest rank of this classification along with Burnside.

Integrating the granites into an exploration strategy

The Pine Creek Shear Zone (PCSZ) passes through the middle of the Cullen Batholith and is known to have a component of vertical displacement in addition to its predominantly sinistral movement, with the eastern block being downthrown.[7] The granites that outcrop on the eastern side are known to exhibit features characteristic of roof region of the pluton,[8] which is consistent with this being the downthrown block. Of greater relevance to an exploration strategy are the granites that do not outcrop or have only a very small surface expression with the greater part of the pluton being concealed. Several concealed granite bodies are interpreted to exist in the area covered by Vista Gold's ELs and significantly, all are interpreted to belong to the Young Igneous Suite,[9] which places them among the granites potentially associated with gold mineralisation.

The contact metamorphic characteristics of the Cullen Batholith are consistent with a depth of intrusion of less than six kilometres.[10] The contact metamorphic aureole associated with granites intruded as this depth would be expected to extend up to 750m from the granite contact. However, the contact aureole around the Cullen Batholith is significantly wider than this, extending for several kilometres in places and up to 15km from the contact.

Two partially-concealed granites with anomalously large contact aureoles are of direct relevance to the exploration program: the Yinberrie and Wandie granites. The Yinberrie Leucogranite is the one most likely to be associated with the Batman mineralisation, being a YIS granite with a high heat production value (though not as high as Burnside or Wandie). It presents only a very small outcrop area to the west of Batman but its metamorphic aureole is very large, with the biotite isograd having been mapped to the east of Batman at a radius of 4-6km from the granite outcrop.

The Wandie granite has several significant characteristics: it belongs to the Young Igneous Suite, it has a heat-production value of the highest rank, and it has an abnormally large metamorphic aureole which extends up to 10km from the outcrop which strongly suggests that the greater part of its bulk is concealed. The Wandie granite therefore has all of the features we should expect to see in a granite body associated with gold mineralisation in the PCO. It has however received very little attention.

[7] Ref?
[8] Klominsky page 21.
[9] Partington and McNaughton, page 32.
[10] Klominsky, page 13.

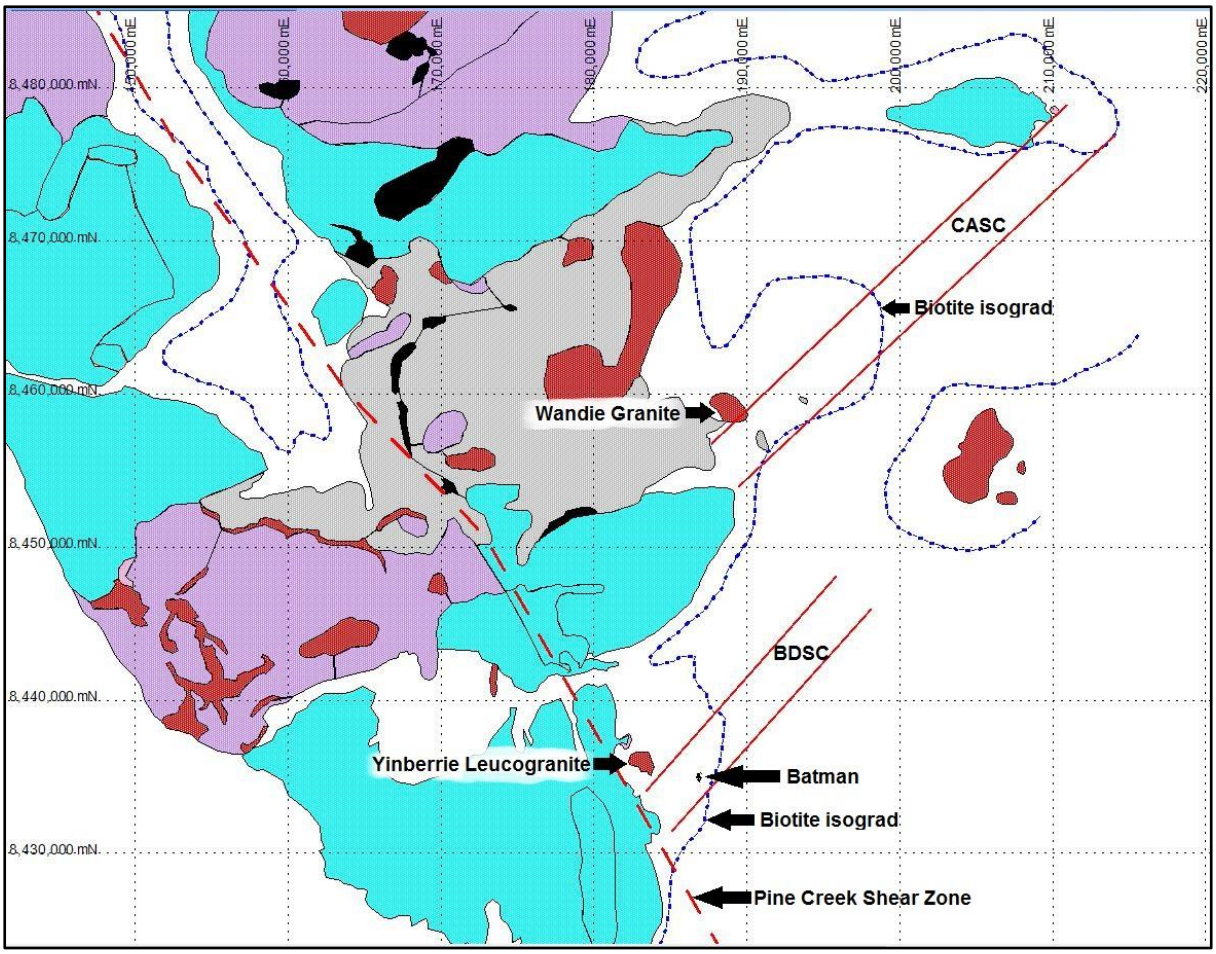

Figure 1: Igneous suites of the Cullen Batholith, showing the YIS in red, with the regional structural framework.

Exploration history of the Wandie granite area

Regional soil lines were sampled between 1994 and 1998 by Dominion Mining, Territory Goldfields and Pegasus Gold. All of these sample lines stopped short of the granite and its metamorphic aureole. One sample, at the end of a line and close to the immediate contact zone of the granite, returned an assay of 54 ppb Au.

An interpretation of the aeromagnetic data was carried out by Southern Geoscience Consultants in 2000 identified several zones of anomalous magnetism in close proximity to the Wandie granite. At least two of these were identified as potentially the result of magnetite destruction. This point is significant if the potential for mineralisation in the style of Coronation Hill or Tennant Creek is being considered.

Coronation Hill and Tennant Creek style mineralisation

While Coronation Hill is described as an unconformity-related deposit, it turns out that the unconformity is not necessary for this style of mineralisation.[11] It turns out that the unconformity at Coronation Hill plays an analogous role to the ironstones at Tennant Creek, and that either one is sufficient to provide the chemical, mechanical and/or redox contrast that the formation of these deposits requires.

[11] Wyborn et al 1994

The key feature of both styles of deposit is that an acidic, metal-bearing fluid in a highly oxidised state must come into contact with lithologies that are reducing or that neutralise the pH. At Coronation Hill, the high oxidation state of the fluids is known to have converted magnetite to haematite, producing magnetic lows in magnetite-bearing lithologies. These are visible in the aeromagnetic data as magnetic lows. At Tennant Creek, the ironstone-forming fluids deposited magnetite, quartz and iron-rich chlorite and are understood to be relatively reduced.[12] As such, their role is essentially as a reductant for the oxidised brines transporting the ore-forming metals.

Ironstones in the Burrell Creek Formation are well known and Goldeneye provides clear evidence that they can be associated with gold mineralisation. The ironstones are interpreted to have formed at the magmatic stage, from heated connate brines.[13] Any mineralisation in these ironstones is interpreted to be a low-temperature, post-magmatic overprint resulting from the radiothermal heat generated by the young, hot granites.

Identifying an amagmatic gold target

The key features of this style of deposit are a young, hot granite with a high heat-producing value, a reducing or acid-neutralising front in the form of a sharp contrast or discontinuity (ideally an unconformity), and basement faults to act as fluid conduits. In the absence of an unconformity, its role in the genesis of the Coronation Hill deposit needs to be filled by some other means. Additional structural complexity is required in order to trap the ore-forming fluids. This is typically an antiform (as per the Dominion model) and is ideally a double-plunging antiform. These are known to be characteristic of D4 deformation in the PCO, which post-dates granite emplacement and is synchronous with the main mineralising event.[14]

There is an additional reason to broaden the focus away from an unconformable contact between the Finnis River and El Sharana Groups when exploring for a Coronation Hill-style deposit. It turns out that the lower units of the Burrell Creek Formation may in some ways be more prospective: the Burrell Creek Formation is informally subdivided into two stratigraphic units, with a lower member consisting of beds containing magnetite and pyrrhotite being conformably overlain by an upper member consisting of prominent, regionally continuous beds commonly mapped as feldspathic grits.[15] The ironstones, therefore, might be more common in the lower units.

Identifying specific targets in the Wandie Granite area

Southern Geoscience Consultants identified two areas of potential magnetite destruction adjacent to the Wandie Granite. Each of these is an area of distinctly low magnetic response in the aeromagnetic data. Importantly, they are also *confined* lows, surrounded by rocks with a relatively high magnetic response, and both sit on a basement fault which is interpreted to run in a SSE direction along the eastern margin of the Wandie Granite.

In addition to the confined magnetic lows, an intense magnetic high also occurs adjacent to the eastern margin of the granite, also directly in line with the basement fault interpreted to

[12] Wall and Valenta, 1990: page 861.
[13] Davidson and Large, 1998.
[14] Partington and McNaughton, page 33.
[15] Nicholson and Ormsby, 1993: page 11.

occur here. This has been flagged by Southern Geoscience as potentially a tight fold structure.

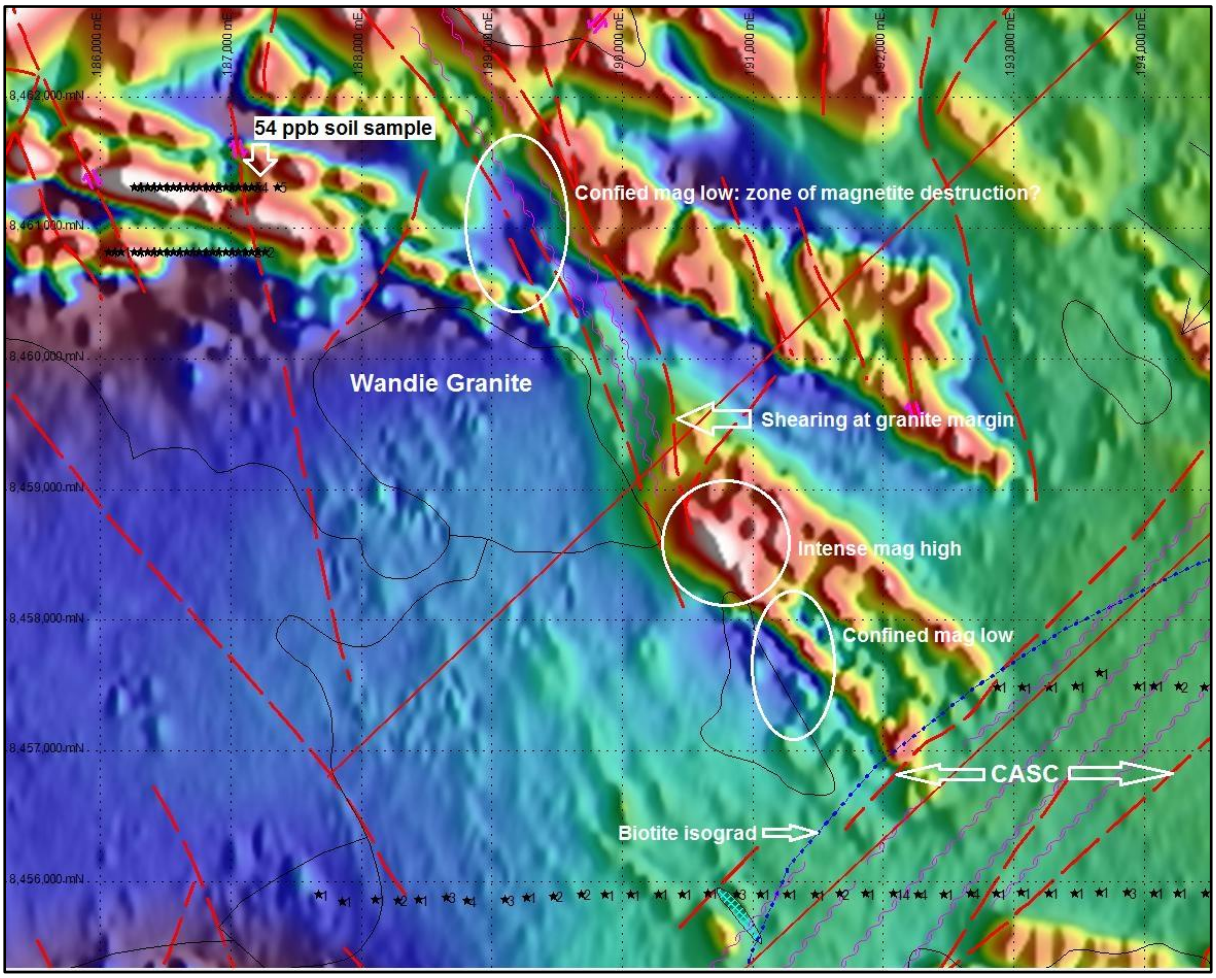

Fig 2: exploration targets adjacent to the Wandie Granite.

Proposed exploration program

A soil sampling grid has been designed to cover each of these aeromag anomalies. The total sample area has been subdivided into four blocks to be sampled in order of priority. The priority 1

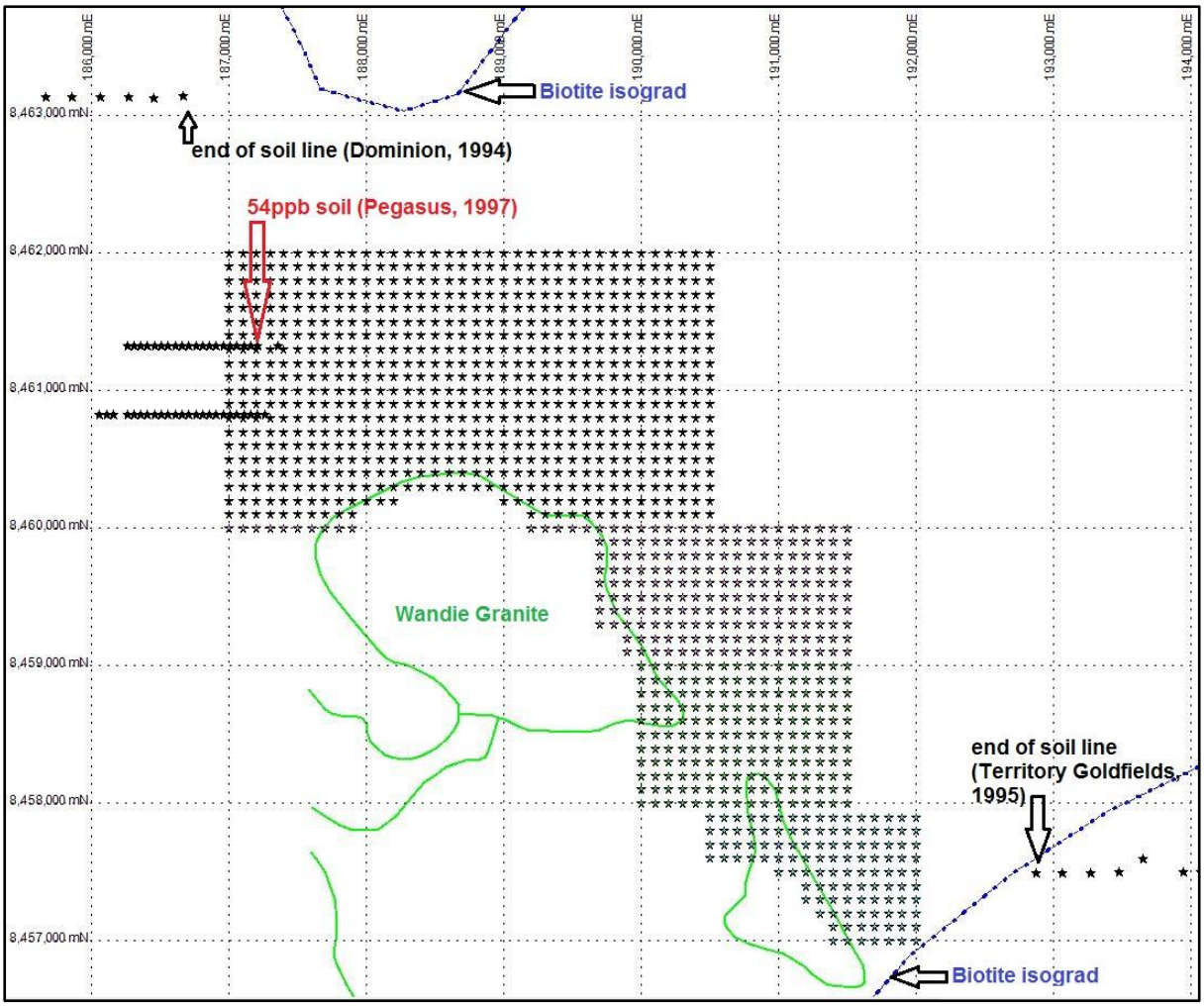

Figure 3: Total area of soil sampling, showing existing sample lines from previous exploration programs.

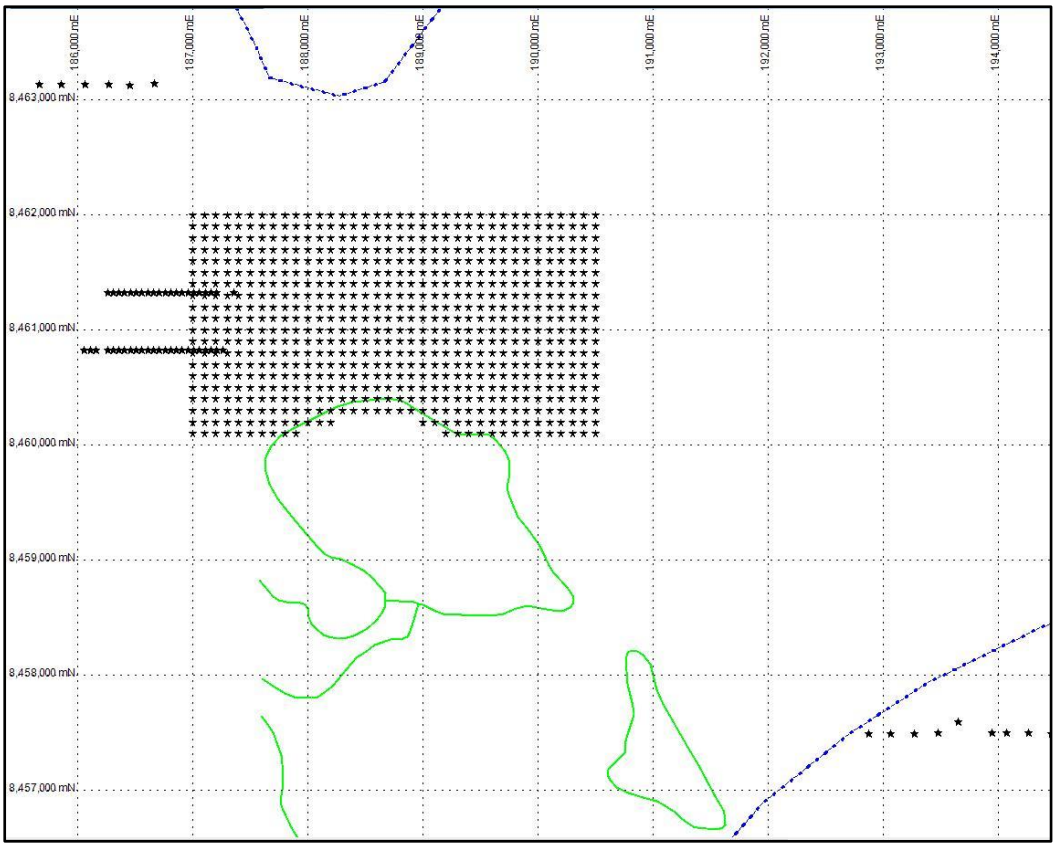

Figure 4: Priority 1 soil sampling, covering the main confined magnetic low.

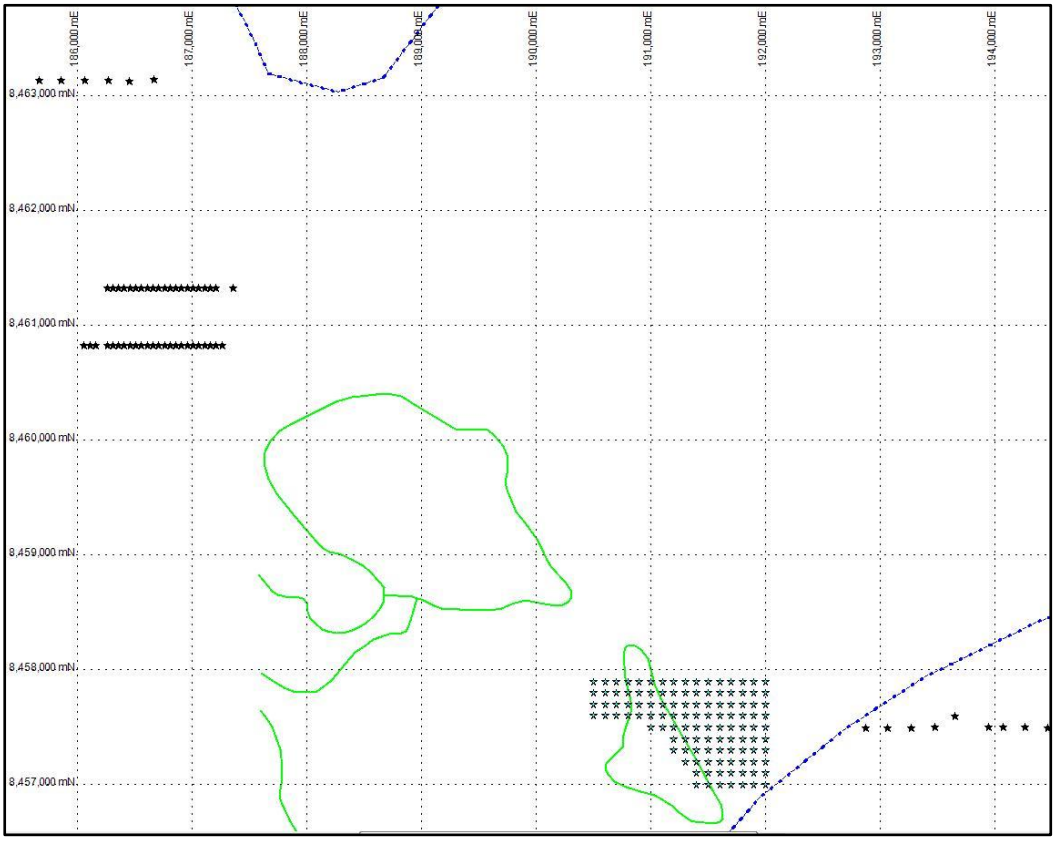

Figure 5: Priority 2 soil sampling, covering the second confined magnetic low.

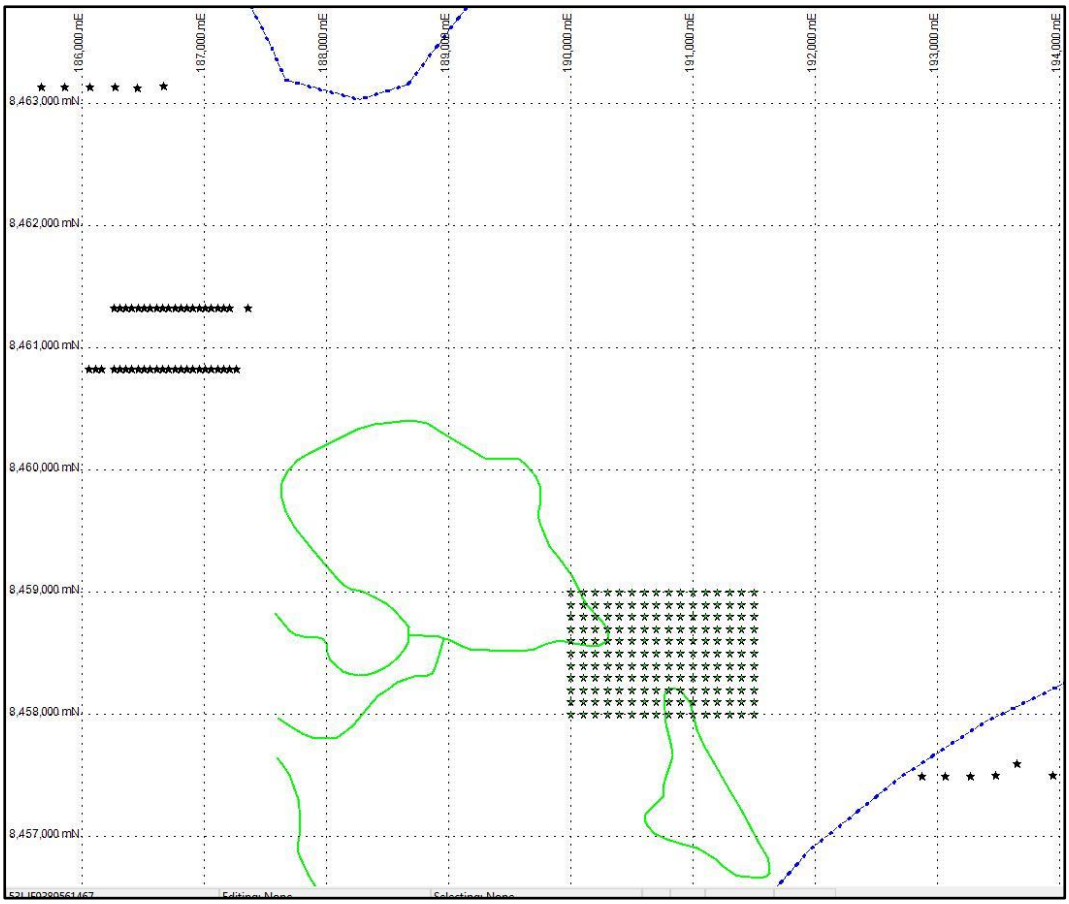

Figure 6: Priority 3 soil sampling, covering the intense magnetic high.