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Undergraduate (BSc) dissertation

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Structural interpretation and quartz vein analysis of the Cothi anticline at Brunant farm, Carmarthenshire: the relationship of Quartz float and arsenic concentration to gold prospectivity

Abstract

The Dolaucothi gold mine has been excavated since the height of the roman empire as the only roman gold mine in Briton. where Gold was mined using rustic methods, uncovering estimates of 20,000 ounces of gold. Since then, numerous companies have revisited the sight throughout the 19^{th} and 20^{th} century, uncovering more gold as technology progressed with estimates of 130,000 ounces extracted. Mining stopped at the start of the second world war with small ventures occurring in the 80s and 90s before all mining ceased as the national trust developed the area into a national heritage sight for archaeologists and geologists to study. Sarn Helen Gold LTD has this year expanded work from Pembrokeshire, now to Carmarthenshire where the opportunity of further exploration around the Dolaucothi mine where student geologists from Cardiff university have taken part in geochemical analysis and structural mapping of licence areas surrounding the mine to build off of previous works in hopes of discovering new or extending the limits of previous mined deposits. The area is a great structural challenge, with the Variscan orogeny both forming and altering the deposit in a series of Silurian and Ordovician age folds. The authors project will examine historical and self-made structural data and soil geochemistry of Brunant farm which lies 1km north of the Dolaucothi gold mine whilst sampling quartz float to determine the orientation of potential gold hosted mineral veins on beneath the surface.

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1.Introduction

Sarn Helen gold LTD (SHG) has undergone its first summer of exploration away from Pembrokeshire in the Carmarthenshire region, focused on the surrounding farms of the Dolaucothi gold mine with the intention to further explore gold potential following its closure in 1939. This project will include data collected during the summer of 2022 from both groups of Cardiff students and their ex-student supervisors now working with SHG and historical data from previous companies work, primarily Anglo-Canadian exploration (ACE) and Cardiff universities Minex department from 1975-1990.

This year's summer fieldwork consisted of pairs of students under supervision of company field supervisors heading into properties under SHG licence where they would complete soils sampling, gold panning and in the case of this report, field observations and mapping to get a better sense of the structural geology of the site of interest. The hope of SHG would be to find gold trends and arsenic anomalies in areas which may lead to further rock core samples and a mining license being granted soon (1-2 years).

1.1 Property description

Within Carmarthenshire there are multiple farms which have allowed access for exploration surrounding the Dolaucothi gold mine and the Cothi anticline which it sits on the southern extent (figure 1.1). Emphasis has been put on the central part of this anticline where elevation is highest with the closest land access being that of Brunant farm. The areas are easily available, bar areas occupied by the national trust due to scepticism over the nature of SHGs exploration, as mineral rights do not need to be considered due to the crown's ownership of any gold rights within the land. There is very poor exposure on the majority area of the hill with high vegetation covering most outcrop sites, limiting structural data collection and observing many clear quartz veins. The ground is a mixture of wooded forest and low-lying grassland towards the peak of Brunant farm which sits on the Cothi anticline.

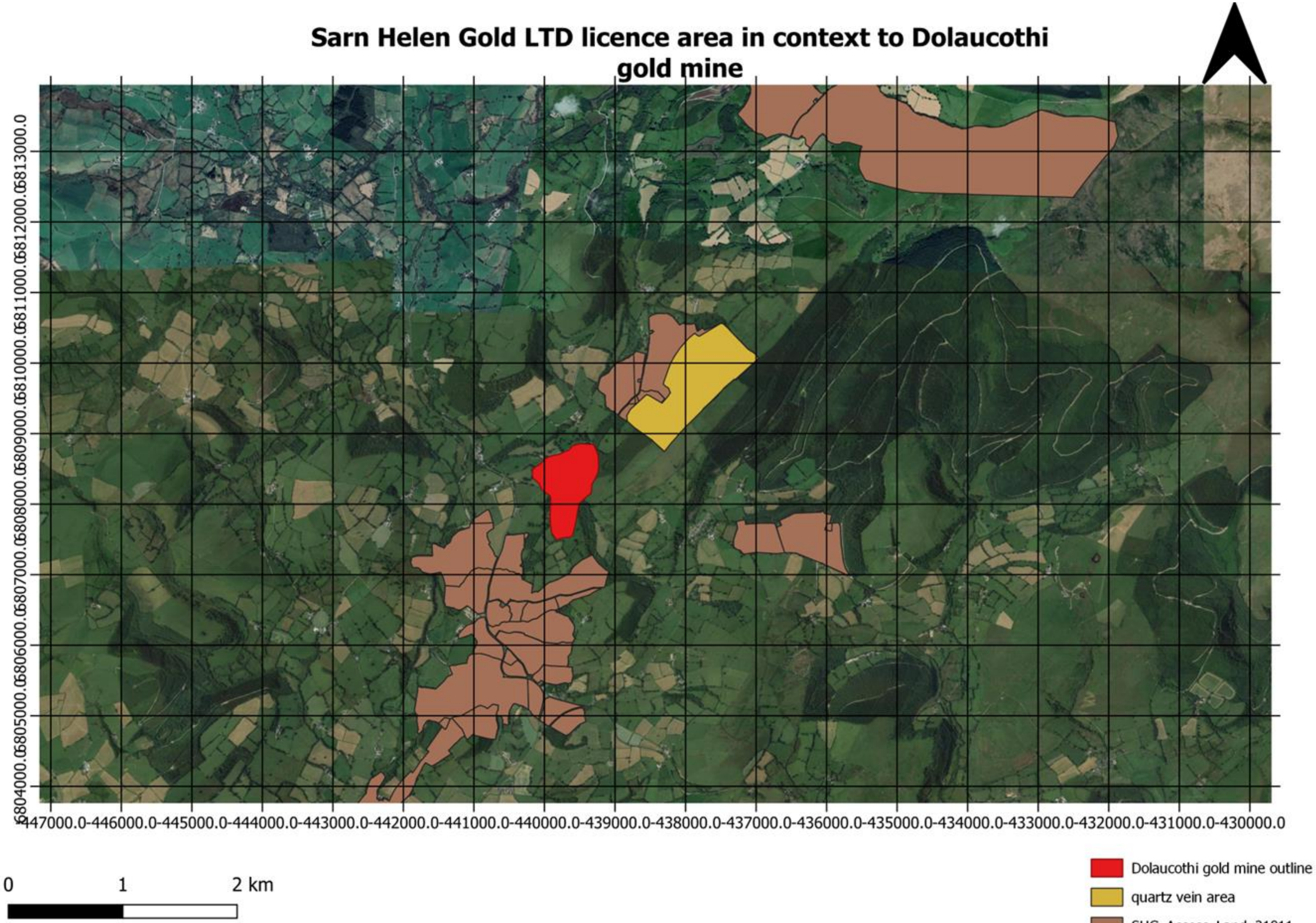

Figure 1 Sarn Helen Gold LTD licence area map. Figure by Joe Stone using data from SHG and QGIS.

1.2 Company background

Sarn Helen Gold LTD is a junior exploration company based in Cardiff which currently takes interest in Welsh gold and exploration in Pembrokeshire and Carmarthenshire, in this case using previous mining ventures as reference for their work on the site. The temporary insertion of Cardiff students into the company for the summer fieldwork provides manpower for SHGs geochemical sampling and gold panning to determine high probability spots of gold mineralisation which in combination with structural interpretation, narrows down the area of interest for future seasons. This report will be sent alongside other students to SHG to assist in better understanding the area and value its potential for future work.

1.3 Exploration history

The Dolaucothi gold mine first made its fame from the Romans who since 70-80AD mined estimates of up to 30,000 ounces of gold (meriting the building of the roman fort to the southeast to protect the mine. Open cast mining and hydro mining were rudimentary methods used to clear topsoil and expose quartz veins rich in gold (Manning, 1968). Evidence of roman work is still seen today nationwide with Dolaucothi being the only Roman gold mine. later in the 1800s mining continued by numerous gold companies e.g. Roman deep LTD (1933-1936) and British gold fields LTD (1937-1939). Due to the second world wars financial burden, gold mining was halted and Dolaucothi has since been abandoned for any mining purpose. Instead, the sight was redeveloped into a site for training and tourism under the national trust with Cardiff university using the site for many years to train students within the mining and exploration sector. Despite small ventures by ACE and other small groups to expand exploration around the areas, no concrete conclusions have been made over possible gold mineralisation and so leads us to present day.

1.4 Student responsibilities

The student undertook 6 weeks of summer placement over July/August of 2022 making up half of the field season. Within this time the student was accompanied by a group of 3 other students whose responsibilities included:

•Taking soil samples at designated positions (30-100 area dependant) within the licence area and recording online the position using GPS for later data analysis. recording observations of colour and texture also took place. teams of 2.

•Completing gold panning at numerous points down the river Cothi and source streams, taking stream sediment samples to record gold concentration, size and shape whilst recording location of data sampling via GPS and noting any observations of the stream itself e.g., flow rate, width, depth etc. teams of 3-4.

1.5 Aims and objectives.

Hypothesis: Quartz float found on Brunant farm gives indication to gold mineralisation on the east most part of the licence area where the Cothi anticline has undergone deformation to accommodate sulphide included quartz veins. This link can narrow down SHGs scope to an area north of the Dolaucothi gold mine where, like the romans prior, quartz veins can be traced to find a reef formation which may host a high concentration of gold.

Aims:

This report will use mostly primary data collected in field to attempt to correlate quartz float localities to arsenic anomalies in soil geochemistry on the Cothi anticline to help determine possible locations of quartz veining where gold mineralisation has likely taken place. Then to contextualise this data in reference to structural geology to determine source and orientation of veins within surrounding bedrock.

Objectives:

•Construct a cross section stretching NW/SE across the Cothi anticline.

•Deduce the likely shape of any major quartz veins along the anticline and relate to arsenic anomalies within the soil geochemistry.

•Create a 3D model view of the topography of Brunant farm overlayed with soil geochemical data to assist in comparing quartz float locations to the shape of the anticline.

2. Geology

2.1 Regional Geology

Carmarthenshire is dominated by Silurian/ late Ordovician aged mudstones and sandstones which describe an era of stabilisation from the Ordovician pattern of erratic climate fluctuations (Holland, 2021) The trend shows younging of rock units within the Silurian proceeding south easterly with exception for some late Ordovician (Ashgill epoch) aged rock units sitting in isolated pockets caused by heavy compression and overturning of the bedrock by the Caledonian orogeny (Annels A.E, 1989) compressing in a similar northwest, southeast direction (figure 2.1).

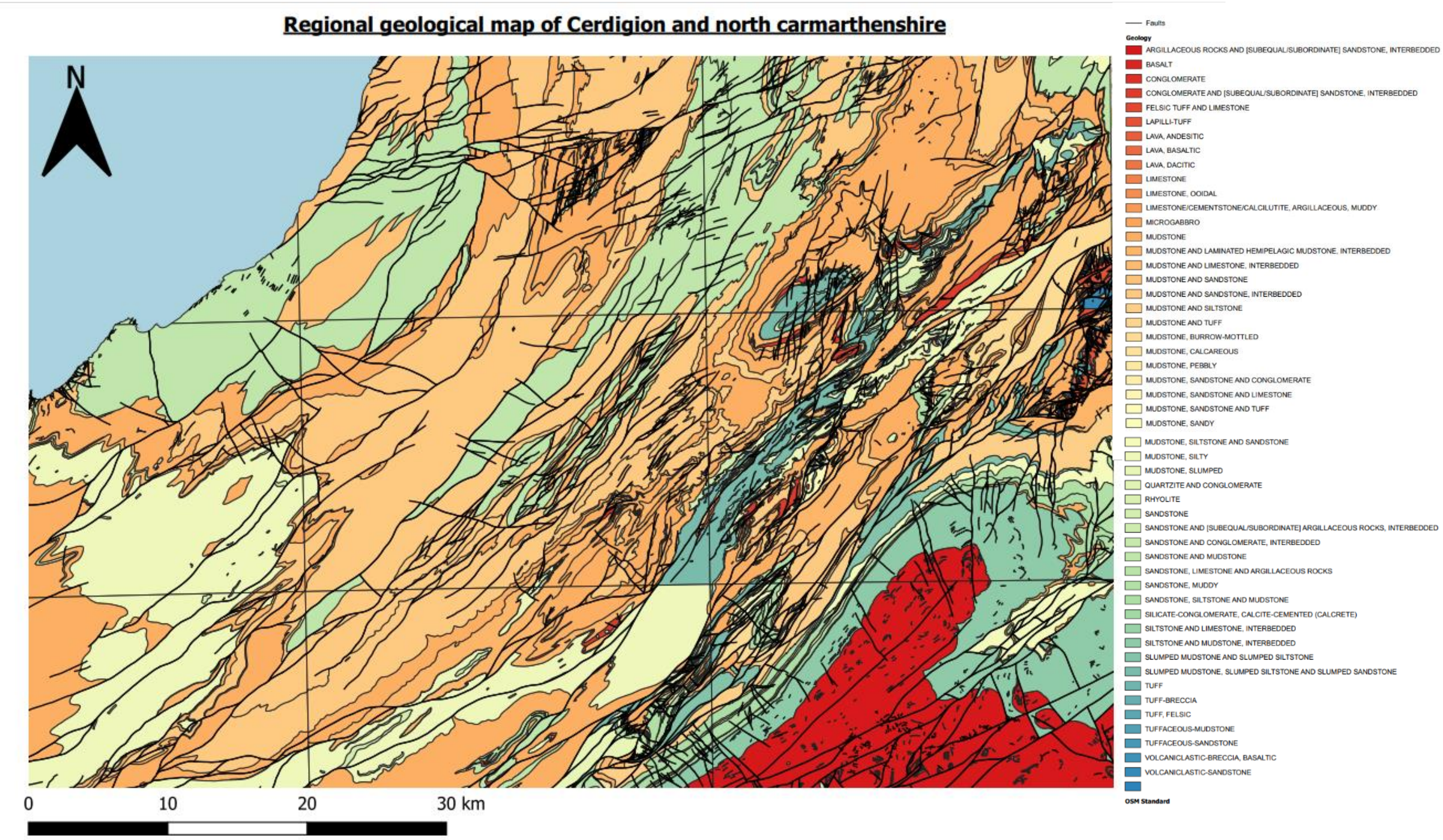

Figure 2 Reginal geology map of Carmarthenshire. Map produced by author with data provided by BGS

2.2 Local Geology

On the Cothi anticline site area sits the exception of late Ordovician turbidites (Ashgill epoch) between later Silurian turbidites Llandovery epoch), both of which are varying forms of sandstones and mudstones (fig 2.2). The presence of these turbidites represent this increase in sea level and lowering of continental land masses from the melting of the late Ordovician (Johnson, 2022). The beds beneath Brunant are tight asymmetrically folded and often overturned on the south-eastern limb (Annels A.E, 1989)One current theory into the presence of gold at Dolaucothi and to the north is that a saddle reef system may be formed as an outcome of folding. The NE-SW compression, derived from the Caledonian orogeny (Annels A.E, 1989), forming the Cothi anticline has also created numerous thrust faults over the area which may have created space for intrusive hydrothermal fluids to infill to the surface. Quartz veins can be seen in scarce locations over Brunant (Fig*), indicating continuation of planar deposits from Dolaucothi, northward where more deposits may sit in various forms. The time frame of sulphide precipitation within the strata is unknown though it is assumed by lack of recrystallisation seen within cored quartz veins (Annels A.E, 1989)that one series of epithermal intrusion into the sheared shale and siltstone units occurred; during or after the deformation events that created the thrust faults and folding at Brunant.

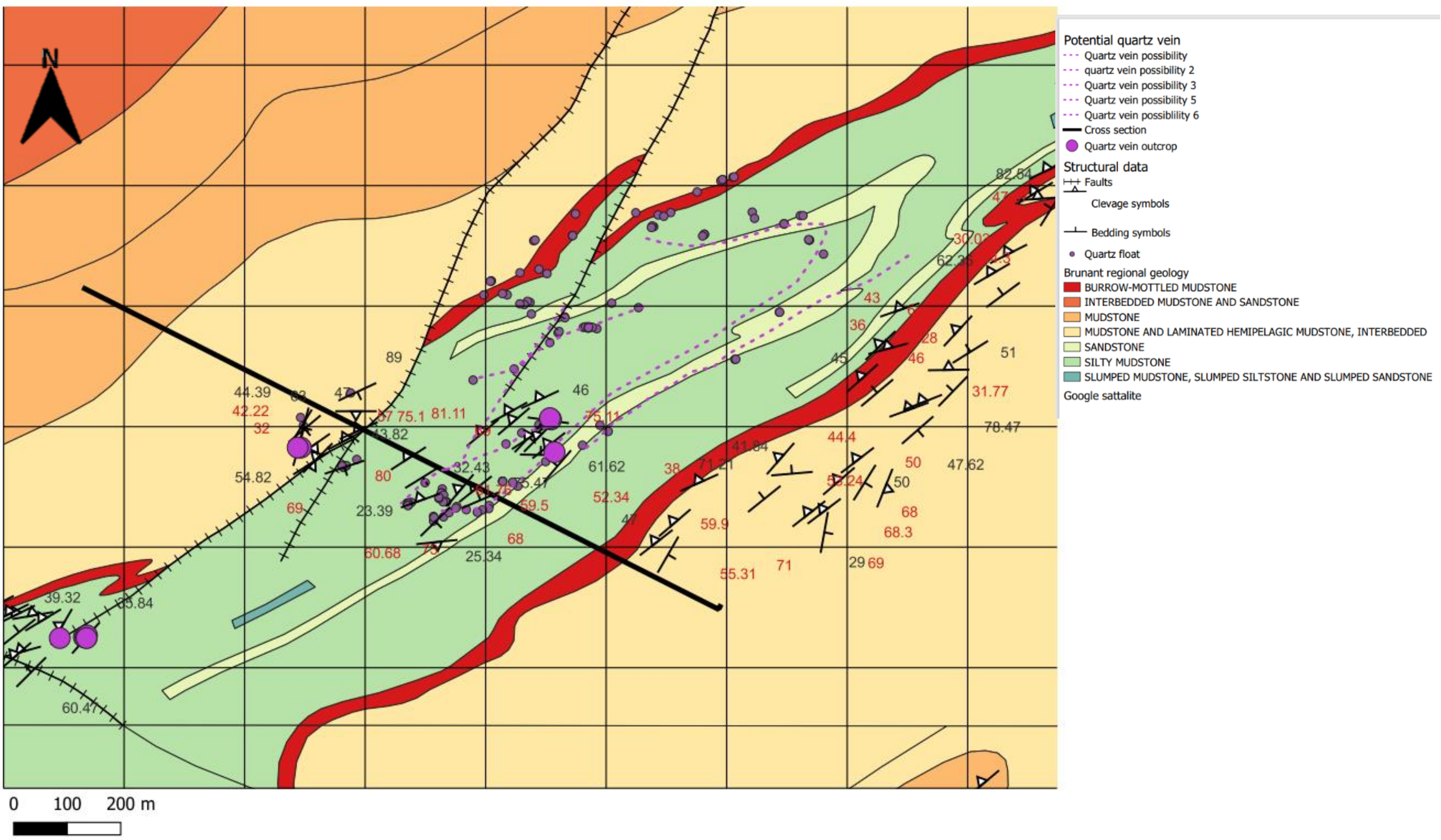

Figure 3 Geological map of Cothi anticline. Map produced by author with data provided by BGS and own source.

3 Methodology

3.1 Land access

Land access was gained from numerous privately owned farms around Brunant each happily providing access for soil sampling and gold panning on their respective rivers which run through their properties. Access of areas were initially identified by using Hm land registry and then small teams sent out before during and now post summer season to introduce the landowners to SHG and ease any suspicions of damage to their land by their activities. The exception was land belonging to the national trust which lay to the south and east of Brunant farm, connecting our area of study to the Dolaucothi gold mine which proved disadvantageous to the project which wishes to find comparison stretching down the length of the Cothi anticline in terms of arsenic anomalies. The areas shown in figure 1 display the areas of access during this summer's field season and in reference to the Dolaucothi gold mine.

3.2 Geological Mapping

Mapping of the Cothi anticline took place over 2 individual days, exploring both sides of the anticline by students and attached lecturer. FieldMove Clino (mobile mapping software) and manual methods of measuring were used on mapping cleavage, bedding and lineation's along licence areas. Other areas where no licence was available were still accessed for mapping as there would be no extraction of soil or rock chips which would damage the area or interfere with wildlife.

3.3 Quartz mapping

On the target area within Brunant farm, an additional area was created following the central and northern fold of the Cothi anticline. In the target area a team of 4 students spaced equally apart, worked through the entirety of the area noting any quartz float and the location on GPS, making observations of any inclusions, crystal size and other features which may give evidence of geothermal processes. Location of float was made to interpret shape and structure of the quartz veins running along the Cothi anticline, while considering their lack of situ and gradient of the slope they sat on when making estimations.

3.4 Soil sampling

The main action of data analysis consisted of 2 pairs of students and supervisors visiting accessible land and completing a series of soil sampling along designated points of 10m spacing down lines 200m apart using a Garmin GPS. This was completed using an Auger and marked bags to collect the soil once extracted. Markings on the bag correlate to the group collecting, the date of the sampling and the sample number to provide record for later analysis using Xray fluorescence (XRF) analysis on site and fire assay data produced using an external company.

This year's sample size was increased from 150-200 grams to 300-400 grams to allow repeats of fire assay on any failed tests which will prevent any failed soil samples from being repeated in the field allowing more time allocation for a higher quantity of data overall.

Some areas require more soil to be analysed due to weight in water in boggy land or rock chips in highland areas. Furthermore, some points had to be sampled multiple times due to lack of available soil with the presence of large rocks and vegetation in or just above the ideal soil layer (B horizon). This was countered by taking samples as close together as possible to avoid any variability. Finally, some areas were slightly out of reach due to leaning onto land out of reach by overlapping onto fence lines or highly vegetated areas which again meant collecting samples at the nearest point available (usually 1-3m away).

The B horizon of the soil unit (figure 4) was the target layer which would go beyond any roots that may concentrate certain elements and potentially contaminate the sample. The auger would insert 1.2m depth depending on accessibility to the B horizon and once extracted a visual assessment of the soil would be taken based on colour, texture and moistness which would be worth considering as factors to any anomalies.

Figure 4 Soil sample on Brunant farm demonstrating the B horizon (Smooth brown soil). Image by Author

The number of collected soil samples varied daily dependent on ground type and accessibility where on open fields, 80-100 samples daily may be taken whilst on steep topographies or high vegetated areas (much of Brunant farm) far less samples (20-40) would be collected. Sample bags were held in larger bags of 5 samples and marked, e.g. sample 1-5, for easier counting away from the field. One member of the pair would carry the large bags whilst recording the location on the Garmin GPS whilst the other would take samples and record the visual features once bagged. Teams would travel within a 100m of each other in case of emergency, with communication between teams via mobile phone and occasionally hand radio in areas where signal was poor.

3.5 Gold panning

Land access by private landowners also provided means of gold sampling on nearby streams, fed by sources from the target area and beyond. As the only major river which flows through all licence areas, the river Cothi was the first water body to be panned during the summer season which would give an initial indication for gold in the area. Once confirmed, panning would then be completed in tributaries of the river closest to the point of gold content to isolate the source of gold in the river. Naturally this would be completed over multiple tributaries as the source may be from multiple smaller streams. Due to the stream's path downhill through highly vegetated areas or steep topographies, safety precautions had to be considered when choosing an area for panning. Therefore, the streams were less systematically picked than soil sampling. Instead, the site chosen would be based off accessibility and where channel flow speed was reduced quickly, allowing sediment build up and gold grains to settle to the base of the sediment as energy was lost.

Once a site was chosen, the team of 3 or 4 dig out 2 buckets of sediment to allow thorough panning but not affect the streams natural flow. This was completed using shovels and trowels to dig up sediment and scrape off any residue from larger rocks and boulders which denser material would collect against. The ideal sediment type are dark clays which are found deeper than the above sand and muds as the denser material (arsenopyrite, gold copper etc) would settle to this zone in the strata due to the clay's density. Once collected in 2 buckets the soil was then poured through a twice differentiated sieve of 10mm and 2mm. the smallest grains 2mm> were then manually panned using a plastic pan. (figure 5)

Figure 5 process of panning fine sediment with plastic pan after filtering through metal sieve. Image by author

After sieving away the lighter material, any gold found in the pan was captured on a piece of blue tape and then placed in a plastic bag marked with a similar format to soil sampling. Any leftover dense material "pan concentrate", may still contain very fine pieces of gold and other useful material so would be put into a separate small plastic bag with as much water removed without losing pan concentrate in the process. This bag contained the pan concentrates of all panning samples on a single point in the river. The sample would be used for geochemical analysis; finding proportions of precious metals or gold supporting materials such as arsenopyrite which forms often in conjunction with gold.

Whilst panning, descriptions of the site such as water depth and velocity would be recorded as well as the sediment the panning was completed in (clays, muds, sands etc). All panning locations were recorded using the Garmin GPS and over the course of the first half of the field season, roughly 8 localities on the river Cothi and connecting tributaries.

3.6 X-Ray florescence analysis

All samples from soil and panning were put through an initial analysis using the portable Xray florescence (pXRF) which was shared between both Lampeter and Pembrokeshire department (figure 6). The pXRF uses x rays to excite electrons orbiting atoms which release electromagnetic waves that can be recorded to identify different elements in the sample as well as their proportions within the sample, recorded as parts per million (ppm). The results were then collected onto a spreadsheet which could be presented on QGIS as a figure. A correlation coefficient was calculated for arsenic and gold which was given by fire assay and added to the spreadsheet.

Figure 6 Demonstration of soil analysis using a pXRF machine. Image by author

3.7 QGIS mapping

Bedrock geology and basic structural data was extracted from Edina Digimaps and used as base layers for overlaying geochemical and topographic data to produce maps shown throughout (refer to table of figures). Field mapping data was combined with historical structural data for producing cross sections of the Cothi anticline with regard made to the minor contradictions between BGS and in person mapping.

4 Results

4.1 Results of geochemical analysis of soil using PXRF and fire assay

On Brunant farm, 854 soil samples were taken with the highest reading for arsenic being 1354 ppm, found amongst the other highest values to the southernmost corner of Brunant. Primary statistics for both gold and arsenic are shown beneath. (Table 1)

Elements	Arsenic (As)	Gold (Au)
Minimum (ppm)	1	0.0005
Mediun (ppm)	40.2	0.018
Mean (ppm)	79.204225	0.04977465
Standard Deviation	147.375898	0.11419773
skewness	5.86746282	5.33335948
maximum	1354	0.92

Table 1 primary statistics of Arsenic and Gold by pXRF. Table by author

4.1 Quartz float sampling

In total 120 quartz float were recorded within a 5.3km² area, ranging greatly in size of float (20cm-1.6m) and individual crystal size from 1mm-4cm (figure 7).

Figure 7Closeup of quartz crystals in float. (Up to 3-4cm large crystals). Image by author

Only one float sample gives indication of sulphide mineralisation (figure 8) due to weathering having removed all but quartz from all samples exposed to the surface. The float exists as a quartz vein running through an altered shale unit which matches the geology surrounding the quarry which the sample was found. Well-formed euhedral crystals cling to the host rock, facing toward each other implying mineralisation following the opening of a shear zone. A thin black coating of tarnished arsenic covers much of the specimen which has been weathered off in other specimens. Chalcopyrite and arsenopyrite is also visible on the specimen in small amounts seen under hand lens (figure 9). This specimen gives ample evidence of mineralisation following the quartz veins and recognising the connection with quartz further south at Dolaucothi (Manning, 1968)

Figure 8 (left) buried Quartz float found at foot of shale quarry. Image by author

Figure 9 (right) Closeup view of quartz float showing off arsenopyrite. Image by Author

4.2 Structural mapping of the Cothi anticline

Mapping attempts on the Cothi anticline have highlighted obvious flaws in BGS's attempt to map the lithology around Brunant, where the boundary of many varying beds are unaccounted. The beds in question however are very difficult to distinguish due to poor quality outcrop hidden by vegetation and Devensian age superficial deposits, and lack of clear bedding.

Despite this, based on surface mapping shown in figure 3 a stereonet produced using data recorded at Brunant (figure 10) demonstrate the axial planar cleavage that defines the NE/SW structural trend. The stereonet also shows the plunge of the Anticline to the north with a dip of 12°.

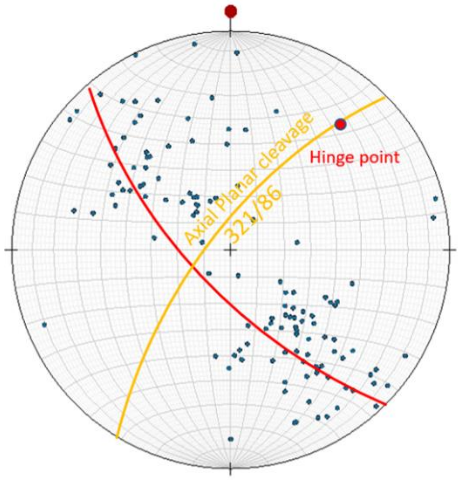

Figure 10- Sterionet from field data collected at Brunant farm. Figure by author

5 Data Analysis

5.1 Geochemical statistical analysis

Relating quartz float to arsenic anomalies within the soil to the conclusion of a link with gold mineralisation requires the correlation between arsenic and gold to be present in Brunant (arsenic being the primary pathfinder for gold in this project). This is achieved using a correlation coefficient between gold and arsenic within soil. The result of this was 0.76065 which strongly supports a correlation between arsenic and gold thus allowing arsenic anomalies to be pursued where gold precipitation will likely exist in tandem.

5.2 Spatial analysis

5.21 Geochemical spatial analysis

Previous geochemical works have been completed by ACE during the 1970s and 1990s with assistance from Cardiff university. Initially this was systematic over a large area around Dolaucothi, narrowing down sampling to Brunant which provided better correlation. This proves advantageous to SHG by expanding sampling into areas previously impossible to sample due to restriction by the national trust. Figure 11 shows the coverage of ACE's sampling in reference to SHG land access and the Dolaucothi gold mine.

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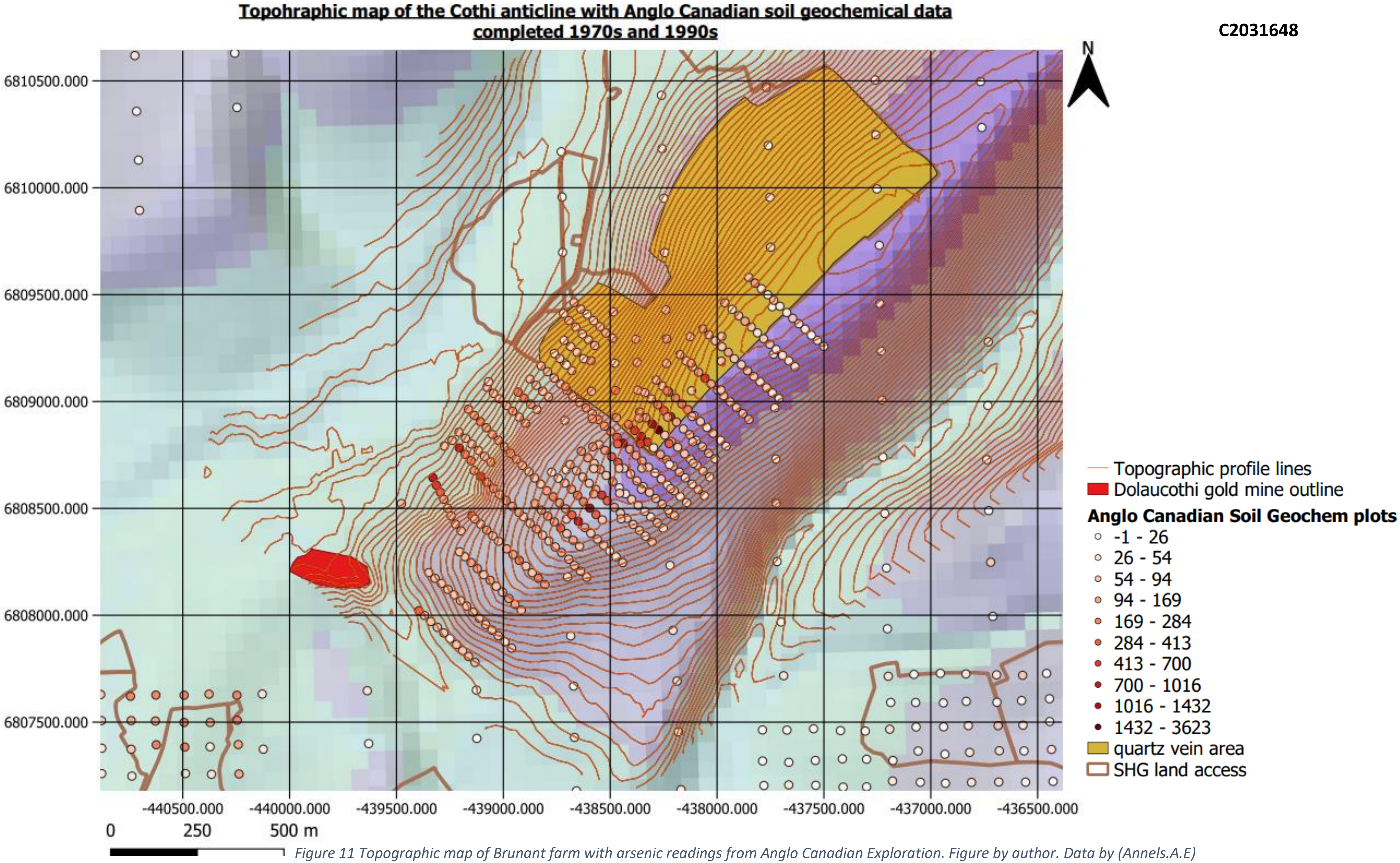


Figure 11 Topographic map of Brunant farm with arsenic readings from Anglo Canadian Exploration. Figure by author. Data by (Annels.A.E)

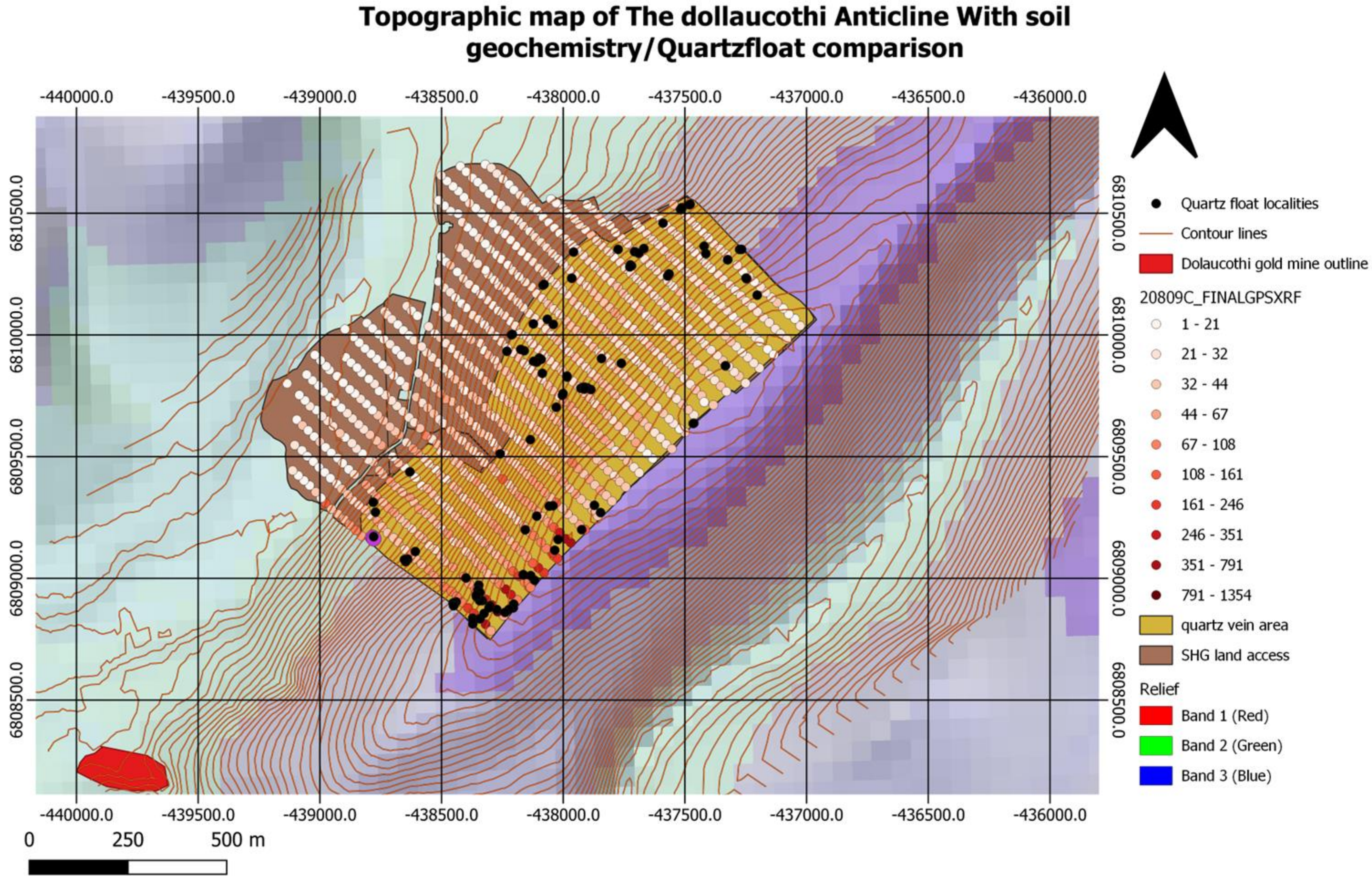


Figure 12 Topographic map of the Cothi anticline. Figure made by author using QGIS. Data by SHG

When compared to SHG sampling on the Cothi anticline (figure12) the two data sets agree on enriched arsenic anomalies on the southern edge of Brunant farm. The presence of this concentration implies a large sulphide deposit in the form of either veins or a reef unit near to the surface where folds have created spaces for depositing and transporting potential gold bearing hydrothermal fluids.

5.22 Quartz float spatial analysis

Accompanying the geochemical points in figure 12 are localities of quartz float sampled within Brunant which follow a trend highly controlled by the topography of the area. By using elevation contours to determine likely areas where the float may have sourced uphill and using the quartz float remaining on the flat peak on the Eastern edge of Brunant, multiple lines following the hinge of the Cothi anticline can be made, showing orientations of suspected veins which follow the lines of concentrated quartz float localities further south. The accuracy of this however is questionable as without being in situ, it is impossible to accurately place the source of the float on top of the slope with the lack of visible quartz vein outcrop.

3D modelling of the area gives a better depiction of the impact of topography on the location of quartz float. As seen in figure 13, the majority of quartz float sit on the same point most arsenic anomalous data correlate. To the north of the vein area float can be seen which have likely fallen down the gradient and settled onto natural plateaus or been stopped by embankments or vegetation. As the arsenic concentration in the soil to the east of these northern floats at the peak of Brunant is relatively low, one could argue these floats do not originate from the same source veins as those to the south. Veins with less sulphide inclusions perhaps hence lower arsenic readings. The variation in float size implies multiple various sized veins extruding Brunant which may be brought by hairline fractures (Annels. A. E., 1982)and larger veins derived from deeper shear faults towards the hinge of the Cothi anticline

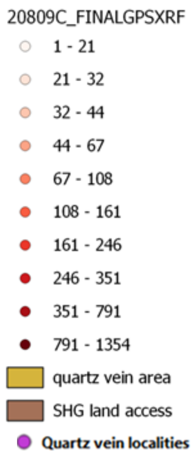
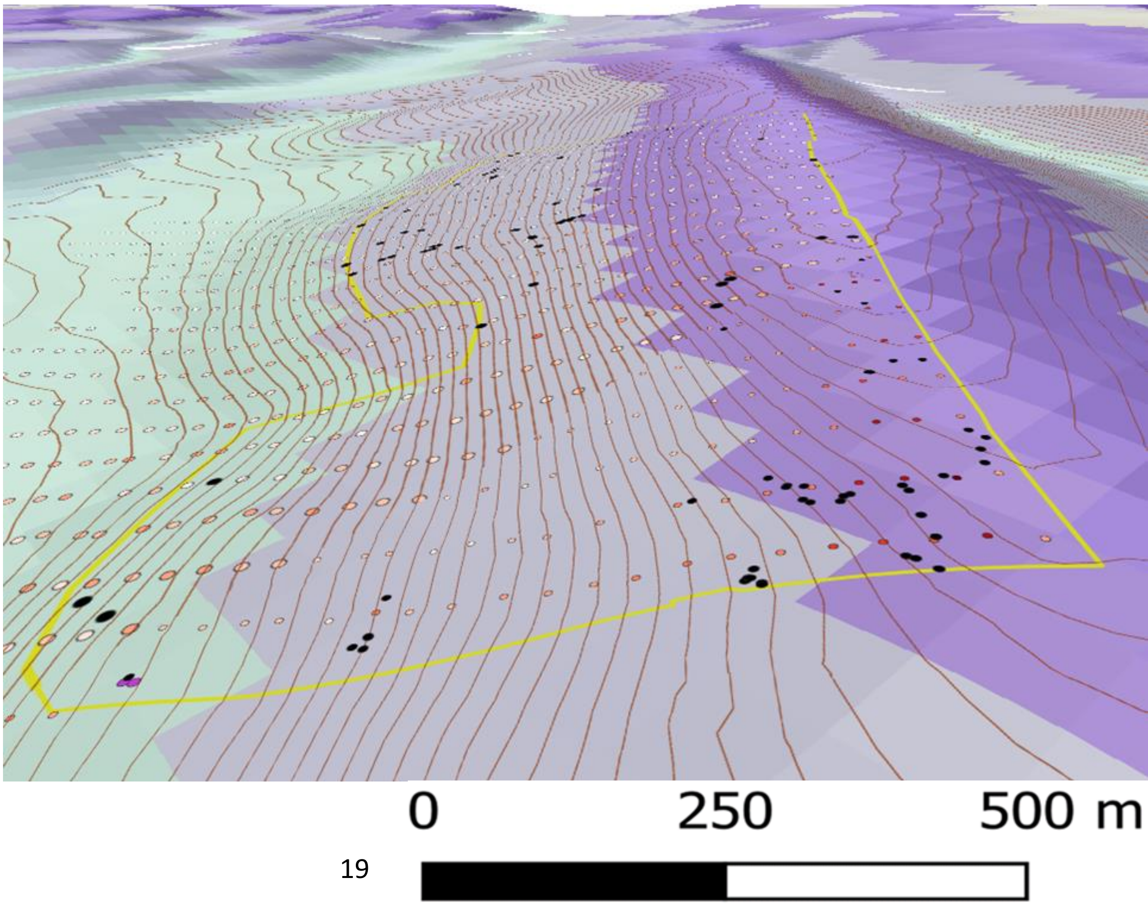


Figure 13 3D view of terrain with Position of quartz float on gradient (facing northeast). Image by Joe Stone using QGIS. data collected by author and provided by SHG



5.3 Structural analysis

ACE have made estimations of the structural geology on the Cothi anticline using drill hole data and field mapping completed in 1981. A localised cross section of the site at the point of drilling was completed (figure14) that describes a steeply dipping planar zone of mineralisation made up of heavily sheared siltstones and shales.

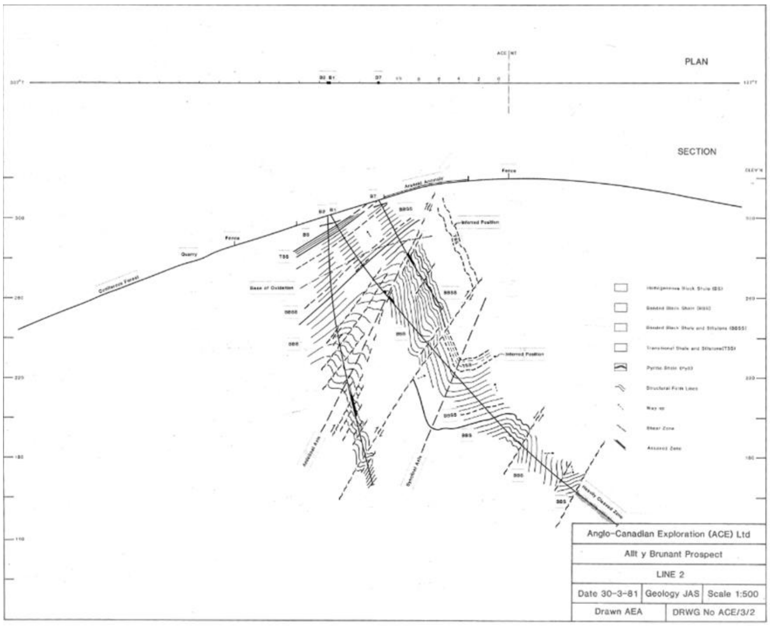


Figure 14 localised Cross section of Cothi anticline highlighting interpretation from drill core samples (Annels.A.E 1982)

The folding within this section conforms SHGs mapping with NE/SW orientated synclinal anticlines. Figure14 shows an interpretational cross section by the author, expanding on the works done by ACE (Annels. A. E., 1982) using field mapping and own interpretation. The structurally complex surface geology is accounted for by the assumption of multiple folds over the Cothi Anticline, all asymmetrical and overturned where recorded way up structures have given the impression of overturning on the south-eastern limb. The anticline is theorised to be doubly plunging (Annels. A. E., 1982) which the sterionet produced by the author confirms. This may explain the lack of anomalous arsenic readings carried north along the brow of the Brunant licence area as any gold yielding shales and siltstones are deeper towards the north and south. This would explain the location of the Roman lode at Dolaucothi which is much deeper than the drill hole data collected by ACE.

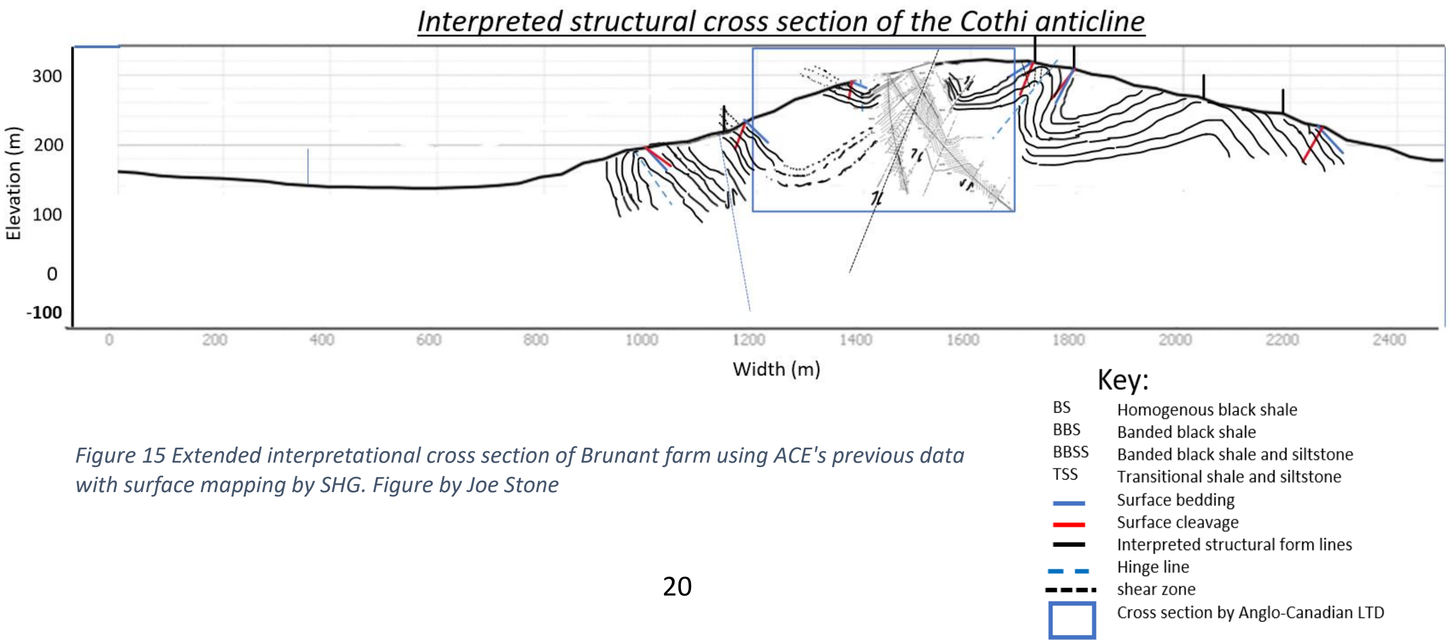


Figure 15 Extended interpretational cross section of Brunant farm using ACE's previous data with surface mapping by SHG. Figure by Joe Stone

6 Discussion

6.1 General discussion

In the first field season in Carmarthenshire, SHG has succeeded in covering a large area while keeping close relation with local landowners to ensure current and future sampling and mapping can progress. This extent ends with the national trust who naturally find issue in the intention of exploration around heritage sights which are used currently for educational purpose and tourism. This therefore prevents land access for SHG on a large portion of high interest sights covering the southern extent of the Cothi anticline, bridging Brunant farm to the Dolaucothi gold mine. Thankfully previous works by ACE has provided information for a portion of the area but not the entirety. Caio Forest occupies the eastern limb of the Cothi anticline and is also occupied by the national trust, denying any further sampling to the overturned limb where other smaller reef systems may exist. Outcrop mapping is still available within Caio forest and allows for occasional exposures to be mapped though with very dense vegetation, outcrops are sparse and highly altered. In relation to National trust influence over the area, it is highly unlikely that any mining will be possible for the reason of planning permission by being alongside and likely into national trust land. Communication with the national trust is very slow and in order to persuade them of the value of the potential deposit at Brunant, a lot more progression in identifying the grade of deposit is needed.

6.2 sampling results

The sampling methods used were efficient at collecting a high volume of samples though the topography range on Brunant and dense vegetation had large impact on the speed of collecting samples in certain areas. Issue from previous years of collecting too little soil to allow repeats of failed assay tests had been remedied by near doubling the amount of soil per sample. The retaining issue however is the consistency of soil collected. Targeting the B- horizon in different terrains can prove challenging where boggy ground or rocky outcrops cover the sample point. The B-horizon can be much deeper than the 20cm usually aimed and require depths 1m< in places. Elsewhere the B horizon is inaccessible due to surface lithology consisting of larger rocks and little to no topsoil. This may create inaccuracies in the anomalous reading of certain areas where soil was least plentiful and O or A horizon soil are the only available horizons which contain a disproportionate amount of arsenic compared to that of B horizon soil (Colbourn, 1975). Perhaps on areas of minimal topsoil, rock chips samples should instead be taken more often to make use of available material whilst also limiting the effect of organic matter on arsenic anomalies in boggy, highly vegetated areas.

6.3 Quartz float correlation with arsenic

The correlation of the two minerals gold and arsenic are key to this project whereby high readings of arsenic will likely follow on to provide high gold concentrations in the same localised area. This is because of golds habit to attach to minerals dense in arsenic such as arsenopyrite and pyrite. If high enough gold will chemically bound to arsenic and stabilise (Goldschmidt, 2021), so appear visible within veins rich enough in hydrothermal sulphides. If we go off this logic, there does appear to be correlation in the position of quartz float to arsenic anomalies along the Cothi anticline. The topography of the area does make estimations vague to the whereabouts of quartz veins themselves which requires further structural data to narrow down, however the large conglomeration of float to the southern tip of Brunant farm, does offer ample evidence of a relation between the quartz floats locality and the cluster of arsenic anomalies which exist within the same 100m^2 area.

6.4 Structural results

The lack of exposure at Brunant makes any current attempt to map the anticline confidently very difficult. However, the bedding/cleavage relationship give us indication of some isoclinal folding and overturning of bedding on the eastern limb of the Cothi anticline. With intense shearing seen in shale units and the axial planar cleavage from the authors stereonet analysis demonstrating the East hinging isoclinal folds, there is much more confidence in the previous works from ACE of multiple microfolds over Brunant displacing shale and siltstones with faults on the fold axis as seen within the authors cross section, creating space for veins to reach upper layers of strata. The major veins located roughly 109m deep from ACE drill hole data (Annels. A. E., 1982) may well connect to many of the surface veins at Brunant and more importantly connect to the site of a large reef unit within the anticlinal structure. The extent of this reef latitudinally is unlikely to be vast due to the double plunging and is currently predicted to strike roughly 100m based on previous estimates by Annels and backed up with the extent of arsenic anomalies in Brunant by SHG.

7 Conclusion

The aim of this report was to assess a relationship between quartz float and arsenic anomalies over Brunant farm to provide evidence for gold hosted mineralisation within the Cothi anticline via quartz veins.

Based on this report there does appear to be a slight correlation in the position of quartz veins relative to arsenic anomalies along the Cothi anticline. The large conglomeration of float to the southern tip of Brunant farm which sits within the same 100m^2 area as the Arsenic anomalies is solid evidence that a relationship exists within the two where topography is not a factor. The topography on Brunant allows the assumption that the quartz float grouping to the north of the area, where topography is steepest, likely formed higher up towards the peak of Brunant. As geochemical results directly east (uphill) from said floats is underwhelming it would be unwise to assume this relationship is consistent throughout the entire extent of the Cothi anticline.

As for contextualising the quartz float and arsenic results structurally with surrounding bedrock, we can assume the doubly folding anticline reaches its most shallow to the surface at the southern edge of Brunant before receding deeper to the north where arsenic becomes less concentrated. It is likely quartz veins have reached the surface to the north but are less saturated in sulphides due to vertical distance from the mineralised zone and may have deposited the float seen at the north of Brunant.

How this relates to prospectivity is that Brunants southern extent may hold host to a reef like deposit that may well be enriched in gold and connect to the deposits seen in Dolaucothi though a mining licence will be very difficult to obtain due to proximity to national trust land which may feel threatened by a new mining operation which could damage architectural areas like the old Roman works which boarder close to the intended mine sight.

7.2 Future exploration recommendations

An extension of Diamond mine drilling to the north of Brunant where the anticline plunges further could prove beneficial to judge the true extent of the reef system latitudinally to the north. The depth of high-grade deposits may mimic the Dolaucothi goldmine where grade increases with depth (Annels. A. E., 1982) and perhaps move the area of importance away from the Dolaucothi itself. This may be easier to exploit due to distance from historical and protected sights whilst providing more confidence to shareholders of a larger zone of gold mineralisation.

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