Farnham Geological Society

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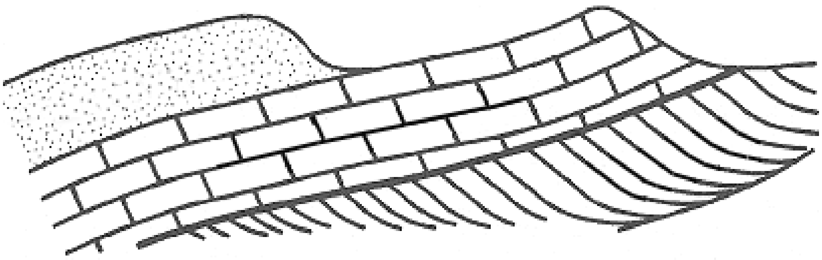

A local group within the GA

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Editorial

In this issue of the Magazine I have to report the extremely sudden, and totally unexpected, resignation of our esteemed Chairman, Graham Williams, who has been a stalwart of the Society for so many years.

I first met Graham over a cup of coffee at BP Research Centre Sunbury on Thames, when he was working on one side of the corridor (in the Micropalaeontology Section of the Palaeontology Department, i.e. the Palaeo Labs) and I was working on the other side of the corridor (in the Petroleum Geology Department, i.e. the rock labs). That was back in ?1968 (so long ago that I cannot actually remember the year) and our paths have crossed intermittently since and then we both ended up on the FGS Committee in the new millennium.

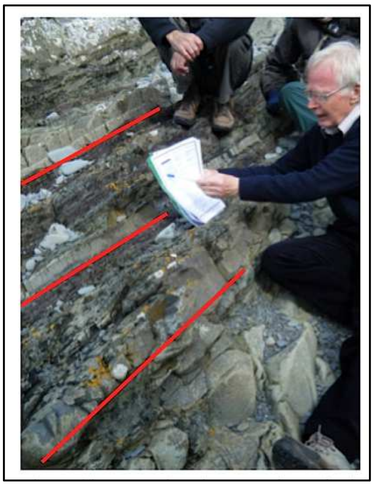
When I compiled the original index of all of the Society's newsletters from 1970 onwards, (*Index now maintained by John Stanley and is available on the FGS website)*, I was amazed by Graham's efforts. In 2005, he ran a series of field trips under the title "The Building of Southern England - Sunday Field Trips" with trips entitled: Albury Traverse; Lias, Dorset; Middle Jurassic limestones of the Cotswolds; Upper Jurassic - Dorset; Lower Cretaceous rocks of Sussex; Middle & Upper Cretaceous - W Weald; Tertiary - Kent. A truly good start to the geology of S England for all members to enjoy.

Then, from 2006-2019, his field trips have covered pretty much every region and every stratigraphic period of the UK. A summary of these field trip locations is included below:

- Scotland: NW Highlands, Hebrides, Caithness, Grampians, Dumfries & Galloway;
- 'N' England: Northumberland, N Yorks, Isle of Man, Derbyshire, Charnwood; Midlands;
- Wales, Ireland: Anglesey, Cardigan Bay, Gower Coast, Severn Bridge, Cork & Ring of Kerry;
- 'S' England: Shropshire, Gloucester, Marlborough, Cotswolds, Dorset, Kent, Sussex, SW Peninsula, Jersey;
- Europe/overseas: Normandy, Brittany, Languedoc, Majorca, Madeira;

An amazing feat; he had a lot of support from his wife Susan and of course from the ever faithful Jack!!

His hard work and dedication will be sorely missed by the Committee and all members of the Society. We are unaware of his reasons for leaving or his plans for the future, but we wish him the very best for a long and happy retirement from Farnham Geological Society.



Graham expounds in Southern Uplands

Graham always encouraged us to check, observe, enjoy

Jack and Susan Are Keen To Keep An Eye On Proceedings

Liz Aston

Building stones of Guildford
Summary of July 2019 field walk led by Dr John Williams, Member FGS

On 12th July, 24 members had a lovely evening for the FGS meeting which was a building stones walk round Guildford. It's surprising how many different stones can be found within a relatively small area of the town, from igneous plutonic to post-glacial indurated sandstones.

We started outside Marks and Spencer where, just within the entrance, three different stones were to be found - at the base of the pillar a black igneous stone (gabbro); above that, a beautiful beige/pink rudist limestone (*rudists are extinct bivalves which often look like large solitary corals, they were common in Jurassic Tethys seas*); and the inner doors had pillars of a grey marble containing iron staining.

A number of shops had the ubiquitous Larvikite or 'Publichouseite'; a building stone which commonly forms the outside cladding for multiple Victorian buildings and bank counters, in the days when we still had banks with counters to lean on. Larvikite is a plutonic igneous rock with large crystals of plagioclase which give the rock its characteristic silver blue sheen. However interestingly to others it is '*cleansing to the subtle bodies and facilitates a strong connection with the energies of Earth, helping to connect with the spirits of Nature. Larvikite stimulates inner visions and enhances our psychic abilities', https://www.charmsoflight.com/larvikite-healing-properties*.

Many of the paving stones are of York Stone - a durable fine-grained sandstone of Carboniferous age. In Chapel Street the edges were paved with large hard-wearing granite blocks to take the wear of cart wheels in days gone by.

- At Mappin & Webb we found green Serpentinite, probably from North of Rome or Northern Greece.

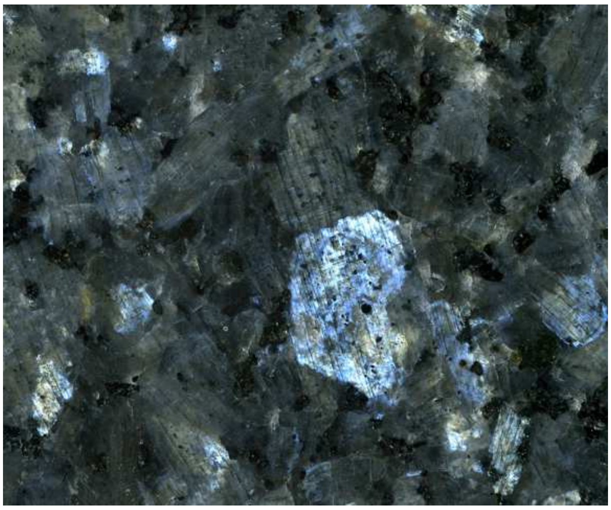
- Next stop was at the castle, built of Bargate Stone (*a hard sandstone, often iron rich and in this case probably from one of the local Greensand quarries*) and clunch (*a limestone which is soft enough to be able to work it easily*) plus some Roman material. Here we had a very interesting talk from Mike Rubbra on the history of Guildford:
    - There was probably a small Saxon settlement on the Western Wey riverside;
    - It is thought that 9th Century Guildford was a small settlement with Alfred's Royal Residence which were located in the (late) St. Mary's area;
    - The town was established 910-920;
    - St. Mary's Church was constructed in 1050.
    - A defensive ditch & bank surrounded the new town.
    - Then early in 1100's, Guildford became a borough.

- On continuing our walk we came to Barbour where there are pillars of Travertine (*a lime precipitate usually from volcanic hot springs, it is porous so is usually coated by 'stop' to prevent corrosion*). The material used would have been full of cavities which have been filled with a mixture of Travertine rubble and resin resulting in the stopped Travertine used here.

- Holy Trinity Church. The original 14th Century church was replaced in 1760 after the mediaeval tower collapsed during 'improvements ' and demolished much of the church. It was a cathedral until the present one was built. The external wall of the old part of the church is a chequerboard of flints and sarsen stones (*sarsen stones are slabs of a quartz-cemented sandstone bed of post-glacial age. The bed(s) originally covered much of S England but the stone remnants are now most common on the Chalk outcrops of Salisbury Plain & Marlborough Downs*). Paving on the south side of the cathedral is of Purbeck or Sussex Marble (*a limestone containing the freshwater snail viviporus paladina).* The cathedral was built between 1936 and 1961 with construction stopping during World War II, which is why the brickwork changes colour half way up the walls, very sad for a building such as a cathedral.

- On to Santander bank - here Jurassic Portland limestone has been used. The limestone has been coated to protect it from weathering.

- At the George Abbot statue & Hospital, the statue base comprises Portland limestone (*used in many very famous buildings, e.g. St Paul's Cathedral, Buckingham Palace, this stone is from a sequence of white-grey limestone beds from the Island of Portland, Dorset; they are late Jurassic in age and can be cut relatively easily*) and granite. The Hospital, built in 1619-22, is of red brick and constructed using English Bond brickwork. The window surrounds are of Portland stone, which is also used for the front balustrade. Local flints are used as a feature at the base of the brick walls.



Larvikite is found in the Larvik Batholith, SW Vestfold County, S Norway. It is 1 of 10 bodies in the Early Permian Plutonic Complex (~295Ma old). These intrusions are in gneisses ~1.1 Ga old in the Oslo Rift, Norway. Large perthitic feldspar (closely intergrown K- & Ca-feldspar) crystals show spectacular bluish-irridescence, from dispersal of light along boundaries of the 2 feldspar crystals. It is known commercially as "Blue Pearl or Emerald Pearl Granite". Photo ex wikipedia, by James St. John

Larvikite – the rock (monzonite with augite) from Larvik, Cvedalen, Norway.
Coin has diameter 23.20 mm.

Monzonite comprises fairly equal amounts of plagioclase (Ca) & alkali (K) feldspar, with <5% quartz & minor amounts of augire, hornblende or biotite.
Photo from Wikipedia, Woudloper - Own work

- St. Mary's church (under heavy restoration) is of knapped flint & Bargate stone. The original church was Saxon but only the tower, built from flint nodules and topped with Bargate Stone, remains from the 11th Century. Carstone cobbles (*carstone is a greenish-brown, cross-bedded, ferruginous sandstone which weathers to brown. It is generally coarse-grained and often pebbly or conglomeratic*) are used to pave part of the church path up to Quarry Street.

  The evening was nicely rounded off by a glass of wine by the river. What could be better?

FGS field trip to Denbies Vineyard on 1st September 2019
Reported by Tony Clarke, Member FGS

Some 14 members of the Society attended this visit which started off with a very ineresting and informative lecture by Professor Dick Shelley of Imperial College on 'The Impact of Geology and Climate Change on two Millennia of British Viticulture'.

An amusing introduction was on the misuse of the work 'minerality' when describing the characteristics of a wine.

Minerality refers to a non-fruit, non-herb, non-spice aspect of the wine which describe aroma or taste or both (think of the smell of a lawn after rain).

The lecture was divided into 3 sections covering Winelands of the Past, Present and Future:

- There was evidence that wine was imported into Britain in the 1st Century AD and that the Celts were heavy drinkers. The Romans planted many vineyards and the Normans listed even more in the Domesday Book. However, in the 15th to 19th Centuries, there was a big reduction in the number of vineyards due to the Black Death and the Little Ice Age.

- In recent times, the numbers have increased dramatically. Here examples were given of the local vineyards and, why they were, where they were. Vines will grow satisfactorily on many different types of soil – chalk, brickearth, river gravels, sands and even granitic. More important are:
    - the temperature,
    - sufficient, but not excessive, rainfall,
    - good drainage but with porosity for storage of water (e.g. fractured chalk in dry valleys),
    - frost avoidance.

Vines help themselves by having taproots which can penetrate the soil for many metres. Generally the vines are planted in S or SE-facing slopes to maiximise the heat from the Sun. Water at the foot of the slope also helps to reflect the Sun's rays.

- In the future, if global warming continues, then it is expected that the planting of vineyards will move northwards, possibly to reach the Scottish Borders by 2080. Sunch increased warming would also affect the types of grapes which are grown at each vineyard, since different grape varieties are most suited to specific ranges of temperature. For example, Denbie's generally grew 'cool' temperature grapes such as Bacchus but are now expanding into Pinot Noir and Chardonnay which require a highter summer temperature.

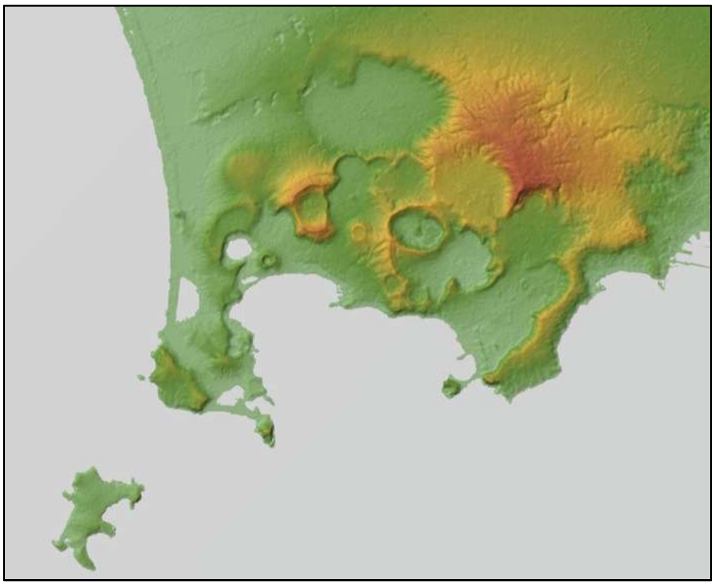
Finally, after the lecture, we were shown a film, primarily about Denbies and then we walked through the winery with its large tans of wine. We finished with, of course, wine tasting.!!!

Summary of following article by Liz Aston:
3D Ultra-High Resolution Seismic Imaging Of Shallow Solfatara Crater In Campi Flegrei (Italy): New Insights On Deep Hydrothermal Fluid Circulation Processes
De Landro, G., Serlenga, V., Russo, G., Amoroso, O., Festa, G., Bruno, P.P., Gresse, M, Vandemeulebrouck, J. & Zollo, A., 2017, Nature, Scientific Reports volume 7, Article number: 3412

The Phlegraean Fields represent one enormous caldera, that of a dangerous 'supervolcano'. It comprises 24 craters and volcanic mounts; most of which lie under water and forming one of the largest volcanic systems on Earth. The area is continuously monitored by the Vesuvius Laboratory, Italy.

These features can be seen in the adjacent map from Wikipedia. The image shows the caldera edges of many multiple small explosions which have occurred over the years.

There have been 3 periods of activity within the Plegraean Fields:



1. **First Phlegraean Period**: eruption of the Archiflegreo volcano occurred ~39,280 or ~37,000 yrs B.P. Widespread discontinuities in archaeological sequences are observed at or after this eruption, and a significant interference with ongoing human processes in Mediterranean Europe is hypothesized.
It is possible that these eruptions drove Neanderthals to extinction and cleared the way for modern humans to thrive in Europe and Asia.

2. **Second Phlegraean Period:** 35,000 - 10,500 yrs B.P., characterized by the Neapolitan yellow tuff, remains of an immense underwater volcano ~15km diameter; Pozzuoli is at its center; ~12,000 yrs B.P. the last major eruption occurred, forming a smaller caldera inside the main caldera, with its centre where the town of Pozzuoli lies today.

3. **Third Phlegraean Period**: 8,000 - 500 yrs B.P., is characterized by white pozzolana, which forms most volcanoes in the Fields.
    1. 10,000 - 8,000 yrs B.P.: initial activity to SW, in the zone of Bacoli and Baiae;
    2. 8,000 - 3,900 yrs B.P.: intermediate activity centred between Pozzuoli, Spaccata Mountain and Agnano;
    3. 3,800 - 500 yrs B.P.: more recent activity towards W, forming Lake Avernus & Monte Nuovo.

Latest/Current Activity:

- The caldera, now essentially at ground level, contains many fumaroles and >150 pools of boiling mud. Several subsidiary cones and tuff craters lie within the caldera; one is filled by Lake Avernus.
- In 1538, an 8-day eruption deposited enough material to create Monte Nuovo; this has risen ~2 m since 1970.
- Today, the Phlegraean Fields comprise the Naples districts of Agnano and Fuorigrotta, the area of Pozzuoli, Bacoli, Monte di Procida, Quarto, the Phlegrean Islands (Ischia, Procida and Vivara).
- A study from the Istituto Nazionale di Geofisica e Vulcanologia shows that the volcanic unrest of the Campi Flegrei caldera from January 2012 to June 2013 was characterised by rapid ground uplift of about 11 cm with a peak rate of about 3 cm / month during December 2012.
- From 1985 to 2011 the dynamics of ground uplift were mostly linked to the caldera's hydrothermal system, but this relation broke down in 2012.
- The ground uplift was driven by periodic emplacement of magma within a flat sill-shaped magma reservoir ~3,000 m deep, 500 m S from the port of Pozzuoli.
- In December 2016, activity became so great that an eruption was feared.
- In May 2017 a new study by UCL and the Vesuvius Observatory and published in Nature Communications revealed that the geographical unrest since the 1950s has a cumulative effect, causing a build-up of energy in the crust and making the volcano more susceptible to eruption; thus an eruption may be earlier than originally expected
- On 21 August 2017 there was a magnitude 4 earthquake on the W edge of the Campi Flegrei area. 2 people were killed and many injured in Casamicciola on the N coast of the island of Ischia, which is S of the epicenter.

It has been suggested that inflation of the caldera centre near Pozzuoli might result in an eruption event within decades. Plans were made to drill down 3.5km near Naples to monitor the massive molten rock chamber and provide early warning of any eruption, but this was initially abandoned in case the drilling initiated an eruption or earthquake but was later reinstated.

Currently there is significant volcanic activity around the dormant Solfatara volcano shallow crater, at Pozzoli. It is emitting steam and sulphurous gases in bubbling mud pools and fumaroles – and is a potentially serious threat to the inhabitants of the area. Hydrothermal activity can be observed at Lucrino, Agnano and the town of Pozzuoli.

Tracking and predicting Solfatara's activity is extremely difficult due to the interactions between magmatic gases, water & steam. But the research project identified in the title of this summary has scientists, which have produced a 3-D map of the caldera with details of water, gas-bearing tunnels & chambers to hopefully predict future explosions.

M7.1 Earthquake At Coso Volcanic Field In Inyo County, California

A recent large (M7.1) earthquake at the Coso Volcanic Field attracted my attention; so I have looked into the Volcanic Field and the Earthquake.

First – the Coso Volcanic Field extruded high-silica rhyolite domes & lava flows during the Pleistocene and represent the early stages of a silicic magmatic system of substantial size and longevity. The Coso Volcanic Field lies on the E side of the Sierra Nevada Mts at N end of the Mojave Desert. The field covers ~390 sq.km, & comprises lava domes, lava flows & cinder cones which have erupted over the past 250,000 yrs. The most recent eruption was ~40,000 years ago.

The rhyolites are occasionally porphyritic (*large crystals, phenocrysts, visible in a background of smaller crystals*) to virtually aphyric (*a fine-grained groundmass and an absence of any visible phenocrysts*).

There are 38 rhyolite extrusions with comparable geochemistry, consistent with differentiation from a more basaltic magma & from a zoned (composition & temperature) magmatic system.

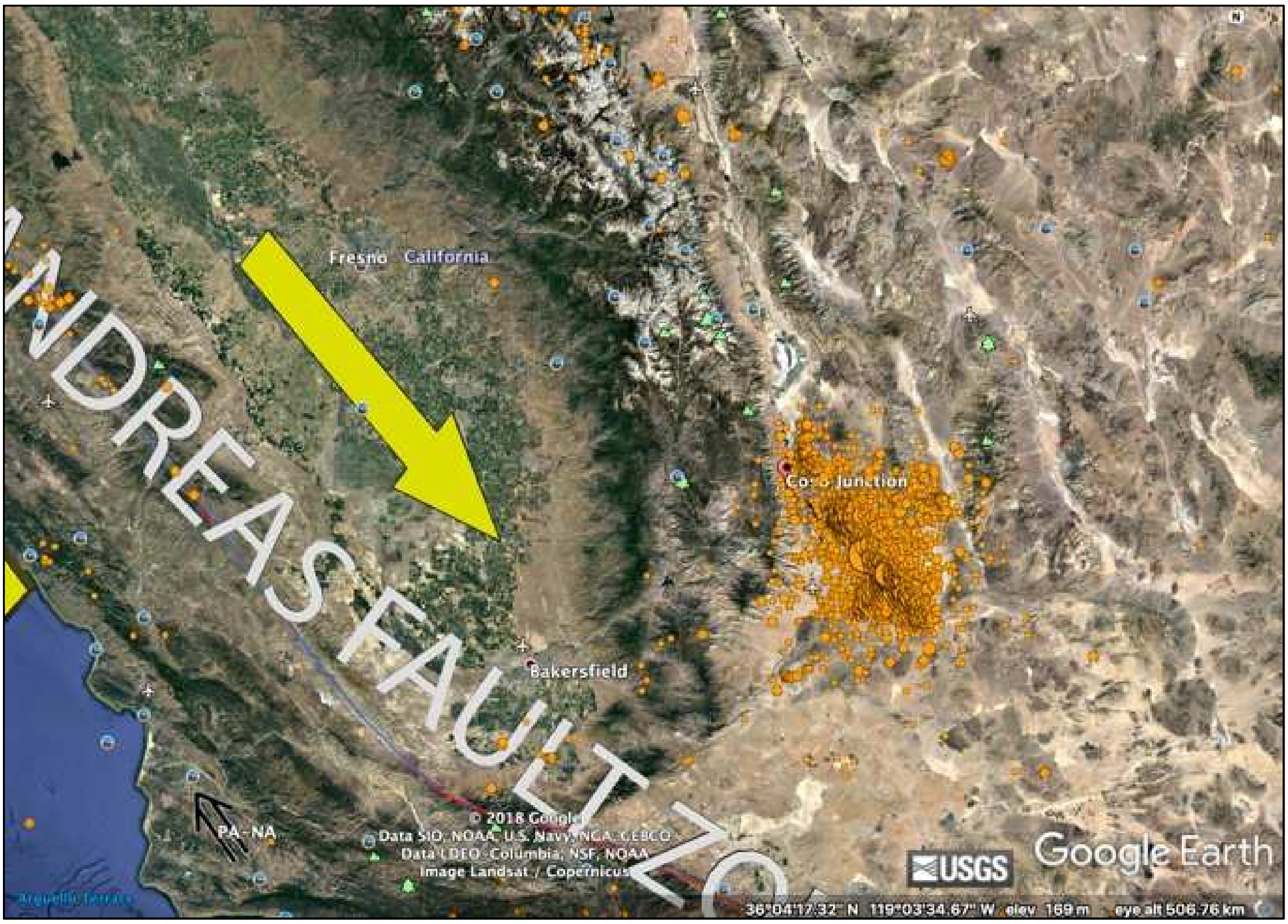
One group of eruptions from ~1Ma to 0.06Ma ago are distinguished by their trace elements; showing that small amounts of magma were bled from the top of a silicic reservoir at a nearly constant long-term rate over the last 0.24Ma. The interval of quiescence between eruptions appears to be proportional to the volume of the preceding eruptions. This relationship may be due to extensional strain accumulated in the roof rocks of the magma chamber.

The mass of magma intruded into the crust to explain the anomalously high heat flow near the centre of the field, together with the age, volume, mineralogical & compositional characteristics of the rhyolites with those of other caldera-forming systems, suggest that the Coso silicic system may contain x00km^3 of magma.

The Coso magmatic system may produce voluminous pyroclastic eruptions if the crustal safety valve becomes inadequate to:

1. defuse the system through episodic removal of volatile-rich magma from its top and
2. prohibit migration of the reservoir to a shallow crustal level.

The summit elevation of the Coso Volcano is currently 2400 m.



Second – The Earthquake Activity in July 2019 - Details compiled from the USGS website about this earthquake is as follows:

"Seismic activity started on July 5, 2019, at the S margin of Coso Volcanic Field, with a M7.1 earthquake, located 17km NNE of Ridgecrest, 1 hour later an M5.4 aftershock occurred, seismic activity continues with ~600 ≥M1.0 aftershocks / day.

The first shock, M7.1, occurred on a NW-trending fault oriented toward the Coso area, and it is common for large earthquakes to cause aftershocks beyond the actual fault rupture.

The intensity of the activity at Coso is gradually declining. Of the approximately 1600 earthquakes (distant aftershocks) detected at M1.0 or above since July 8, only 12 have been M3.0 or above, with the largest two registering M4.1.

No ground deformation indicative of volcanic activity has been detected, and there is no imminent threat of an eruption."

The current activity at Coso can be considered distant aftershocks. The initial M7.1 quake occurred on a NW-trending fault oriented toward the Coso area; such large earthquakes frequently cause aftershocks beyond the area of the actual fault rupture.

Reference:

The Pleistocene high-silica rhyolites of the Coso Volcanic Field, *Charles R. Bacon, Ray Macdonald, Robert L. Smith, Philip A. Baedecker;* 1981 https://doi.org/10.1029/JB086iB11p10223

Summarised by Liz Aston, Editor

Stonehenge and other Neolithic sites of the UK

Having recently taken my three granddaughters to Stonehenge, Wiltshire and my two grandsons, plus friends & their mother (an archeologist) to L'Etacq, St Ouens Bay, & La Hougue Bie, Jersey, I was totally reinvigorated by the children's enthusiasm & amazement at the remains and edifices made by our forefathers.

At Stonehenge it was the fact that the whole circle was i) a circle, ii) had the Sun's rays passing through a gap, but, in particular, iii) stones themselves so huge (they tried to pull one). For my grandsons it was fact that La Hougue Bie was so old and in such a good condition, lovely to go into and look around.

I then came across an article about Crannogs – tiny islets common throughout Scotland & Ireland which also turn out to be of a similar archaeological time.

In a nutshell:

- The building of Stonehenge started at ~3000BC and is an iconic structure of Neolithic peoples showing sophisticated skilled and dedicated efforts to transport & erect such huge stones.
- The burial site of La Hougue Bie is even older, ~4000BC, and is one of the best preserved remnants of the Neolithic period in Western Europe.
- The artifacts at L'Etacq are part of the Early Neolithic settlements at St Ouens Bay, W coast of Jersey, dated at 4850-4250 BC.
- Then the Crannogs of Scotland.

So, starting with the oldest first:

St Ouen's Bay: along the W coast of Jersey, there are extensive peat deposits (now covered over) which formed >6,500yrs ago, and became home to some of the earliest settlers on Jersey, the Early Neolithic farmer/fishermen. The peats formed in a brackish lagoon, with areas of older fen and a sand bar which protected the lagoons from the Atlantic Ocean. There were lakes and pools, which formed watering holes for their cattle, and hoof prints have been found round these.

At the N end of the Bay, close to l'Etacq, there are exposures of the peat along the back of the beach, which are exposed at times of low tide and in which footsteps of such a farmer have been found by my archaeology friend, walking along the beach & beside these are prints of his cow's hooves. Also within this peat exposure, many irregular-shaped, smooth, white, cobble-sized rocks have been found which were thought might be flint, if so they would probably have been sourced from France or mainland UK (as there is no flint on the island).

However, examination of these 'white cobbles' showed that their surface is very slightly rough, and, when they are broken, the rocks are seen to be dark grey (they have been bleached white by lying for thousands of years in the peat). They are in fact very fine-grained, very well sorted sandstone made almost exclusively of quartz grains. They are quartz-cemented, either through diagenesis or by metamorphism within the aureole of the nearby granite intrusion (or possibly both).

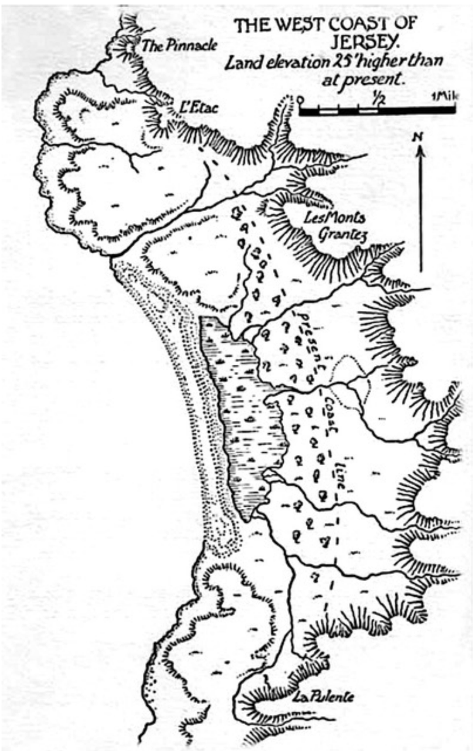
These ‘cobbles’ feel like extremely fine sandpaper to the touch and my theory is that they are the nearest rock to flint that was available on the island and thus would have been ideal tools for removing hair and cleaning their hides. These sandstones are of turbidite origin and form part of the Jersey Shale Formation beds which crop out at this end of the Bay.

The whole of St Ouen’s Bay is known to have been an important place for people during the early Neolithic because:

- the sea there is full of many different types of crustaceans, fish and shellfish;
- the land behind the coast was accessible with suitable pastures for cattle, sheep, goats, etc. and
- pools and areas of woodland were full of wild fowl.

However the area of L’Etacq, at the N end of the Bay, would have been a particularly good place to settle as, together with the benefits noted above, this particular location had:

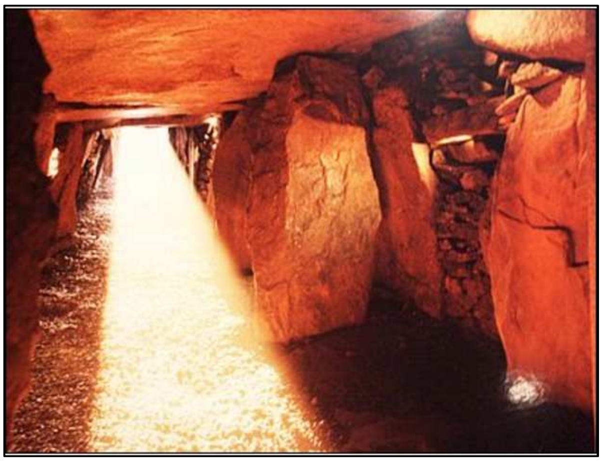
- shelter from the cold, N & E winds by the high granite cliffs at this end of the Bay;
- a small, sheltered bay (Le Pulec) with safe access to the ocean and easy passage up the beach to the land;
- the Pinnacle, a shoreline stack, N of Le Pulec, is close & reported to be doleritic and thus suitable for axe heads; it has artefacts of Neolithic times there;
- the inland stack at L’Etacq comprises the turbidite sequences and is possibly the source of the ‘flint-like’ meta-sandstones within the peats of this area which would have been useful for leather treatments;
- the local granite body has veins with molybdenite, chalcopyrite, pyrrhotite (attractive & of use in the Chalcolithic period).



Above R: Items from the peat exposed at N end of St Ouens Bay, Jersey: – wood from the peat (top) and ‘white stones’, actually v.f.gr., dark grey turbidite meta-sandstones, bleached white by incarceration in peat for thousands of years.
L: Map of St Ouen’s Bay during the Neolithic, 4,850-4,250 BC, showing ocean, sand barrier, coastal plain & pastures.
https://www.theislandwiki.org/index.php/File:Menhirs1.jpg

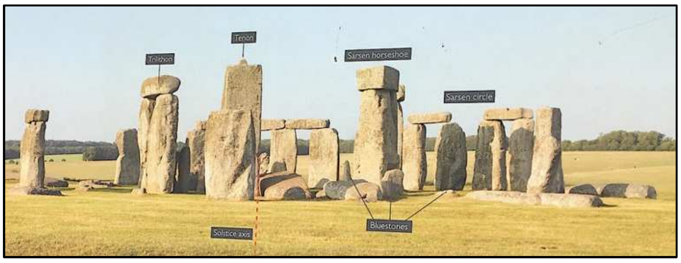
The coastal lagoons along St Ouens Bay were flooded during a period of post-glacial sea level maximum which washed the sand bar inland to form the current dune field and the populations would have moved inland. The Neolithic peoples have left many megalithic monuments along this coast (e.g. Les Monts Grantez & La Sergenté).

La Hougue Bie, Jersey, 4,000BC, the chapel on top of the hill is relatively recent.



The sun shining through the entrance at La Hougue Bie, at the equinoxes.

Le Pinacle, Les Landes, Jersey, with remains & ruins at its base from Neolithic & Chalcolithic periods, the Bronze & Iron Age



Images of Stonehenge – above mine below from the adjacent Museum.

For Stonehenge and La Hogue Bie (LHB), the Neolithic peoples celebrated the equinoxes –

- every spring and autumn people gather to watch the equinox from inside the chamber of LHB.
- similarly people (druids & pagans) gather at Stonehenge to watch the sunrise as in the image to the left.

The curator at LHB explained that the name means man-made mounds and homestead to Vikings but it is best known as a burial ground with rituals associated with seasonal farming activities and that the equinoxes were very important to the Neolithic community.

Research & photographs about Jersey sites are taken from:

https://www.jerseyheritage.org/heritage-landscape/dolmens-and-passage-graves
https://en.wikipedia.org/wiki/Archaeology_of_the_Channel_Islands
https://en.wikipedia.org/wiki/La_Hougue_Bie
http://www.prehistoricjersey.net
https://www.theislandwiki.org/index.php/Surviving_menhirs

Stonehenge: (based on Wikipedia & my visit to their Museum): Stonehenge (*a henge is an earthwork consisting of a circular banked enclosure with an internal ditch*) comprises a ring of standing stones, each one ~4.1m high & ~2m wide and ~25 tons in weight. (*They have one for people to attempt to pull along on plank on top of logs*.) The stones are set in the middle of a dense complex of Neolithic and Bronze Age monuments, including several hundred burial mounds (mainly circular barrows); they are scattered, and very visible, all around the area. At Stonehenge, the bank is inside its ditch, thus Stonehenge is not truly a henge site.

The outer stones are made of hard quartz cemented sandstones, called sarsens; they are local rocks found scattered over the Chalk downs of Wilstshire and Marlborough – they are thought to have formed as silcretes; the result of localized patchy cementation at or just below the surface of Tertiary sands.
The inner ring are called bluestones - they are composed of dolerite and rhyolite from the Preseli hills in the Pembrokeshire Coast National Park. Dr Richard Bevins (National Museum Wales) and Dr Rob Ixer (UCL & U. of Leicester) have identified the outcrop of Carn Goedog as the main source of Stonehenge's 'spotted dolerite' bluestones and the outcrop of Craig Rhos-y-felin as a source for one of the 'rhyolite' bluestones (see image below).

Les Monts Grantez, Jersey: Neolithic passage grave ~4000-3250 BC; a passage leads to an asymmetrical chamber with a single side chamber. A mound covered the structure to 1912. Skeletons of 6 adults & 1child were found in the chamber, all in a crouched position, lying on their sides and accompanied by limpet shells, bones of cattle, deer, horse, pig and goat & small piles of brightly coloured pebbles. An 8th skeleton was buried in a seated position in the passage. Other finds: pottery, stone implements, a spindle whorl.
https://www.megalithic.co.uk/modules.php?op=modload&name=a312&file=index&do=showpic&pid=5797

La Hogue Bie (LHB), Jersey.
Inside the chamber.
Every spring and autumn people gather to watch the equinox from inside the chamber of LHB.

“The rocks at these locations, form natural pillars, allowing the prehistoric quarry-workers to detach each megalith (standing stone) with a minimum of effort”.
"They only had to insert wooden wedges into the cracks between the pillars and then let the Welsh rain do the rest by swelling the wood to ease each pillar off the rock face" said Dr Josh Pollard (U. Southampton). "The quarry-workers then lowered the thin pillars onto platforms of earth and stone, a sort of 'loading bay' from where the huge stones could be dragged away along trackways leading out of each quarry."

Stonehenge was built during the Neolithic period, between 3000 & 2000BC. The surrounding circular earth bank and ditch, which constitute the earliest phase of the monument, have been dated to ~3100BC. Evidence of a ring of wooden poles, embedded in postholes, encloses the present circle of stones and is a lot larger in diameter. Stonehenge could have been a burial ground from its earliest beginnings. Deposits containing human bone date from as early as 3000 BC, when the ditch and bank were first dug, and continued for at least another five hundred years.

The first bluestones were raised between 2400 & 2200 BC, although they may have been at the site as early as 3000 BC.

Stonehenge evolved in several construction phases spanning at least 1500 years. Evidence of large-scale construction on and around the monument probably extends the landscape's time frame to 4500 BC.

At 8000BC, Salisbury Plain was wooded; by 4,000 BC, earlier Neolithic, people built a causewayed enclosure and long barrow tombs in the surrounding landscape. At ~3500 BC, a Stonehenge Cursus was built 700m N of the site as the first farmers cleared the trees and developed the area. Other stone, wooden structures & burial mounds may date to 4000 BC. Charcoal from the 'Blick Mead' camp 2.4 km from Stonehenge has been dated to 4000 BC.
Many archeologists believe that the community who built Stonehenge lived there over a period of several millennia.

Crannogs - Artificial islands older than Stonehenge:

Summarized from Nat Geog June 12, 2019; The Independent & Science Alert
Matthew W. Chwastyk, NGM Staff; Vicki Cummings, University of Central Lancashire
Duncan Garrow, University Of Reading, U.K.; Fraser Sturt, University Of Southampton, U.K.

A study of crannogs in Outer Hebrides reveals some were built >3,000 yrs BC. But their purpose is unclear? The only records of the lives of the Neolithic people, are those items which have survived destruction - typically stone circles & monuments; a new type of 'structure' is now confirmed as Neolithic in origin - the Scottish crannogs. These are artificial islands & are common throughout Scottish & Irish lakes and rivers.

They were thought to have been constructed by Iron Age people (800-43 B.C.) but nearly 600 crannogs are found to be ~3,000 years older, some >3,300BC, i.e. Neolithic, suggesting a different (?more advanced) behavior for the Neolithic period.

Evidence of Neolithic Crannogs in the Outer Hebrides

- a supposed Iron Age islet in a loch, N Uist, is actually a Neolithic site;
- divers found distinctive Neolithic pottery in waters around crannogs, confirmed as 5 artificially constructed islets of Neolithic origin;

The islets were used for millennia, so few Neolithic things were found on land, however in the waters surrounding the islet they have found a lot of 3000-4,000BC pottery, nearly intact Neolithic ceramic vessels.

Vicki, an expert in Neolithic monuments, considers these crannogs to be intentionally isolated from everyday Neolithic life & death (they are located away from domestic settlements & there is a lack of tombs or human remains). They are not trivial structures, some of the stones in crannogs weigh ~250kg.Neolithic Britons loved building things with big rocks, but the crannogs are unlike these settlements or other monuments. The sites' isolation, and the pottery that surrounds them, could point to rituals that marked life transitions, e.g. passage from childhood to adulthood.

Further research is going to be undertaken using side-scan sonar to spot underwater objects and satellite photos to spot new islets, the 'Iron Age' sites will be reconsidered.

Above: Typical Scottish Crannog from https://www.crannog.co.uk/what-is-a-crannog
To Right – from the Independent:

Above: An aerial view of Eilean Dòmhnuill Crannog, N Uist. Photograph by Getmapping PLC https://www.sciencealert.com/mysterious-artificial-islands-in-scotland-are-thousands-of-years-older-than-we-knew
Below to R: photograph by Richard Law

Islands with known Neolithic material are: Arnish, Bhorgastail, Eilean Domhnuil, Lochan Duna, Loch an Dunain, Langabhat

Liz Aston, Newsletter Editor

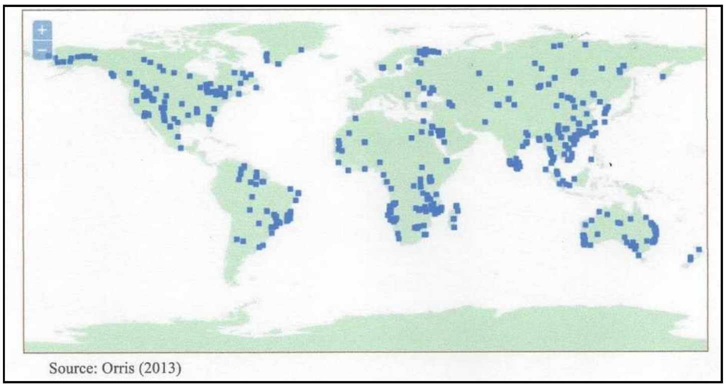
Rare Earth Elements - REE

The REE are scandium, yttrium and the 15 lanthanide elements; they are frequently found with uranium & thorium which have similar chemical properties. The rarest are thulium and lutetium but these are more abundant than the precious metals such as gold.

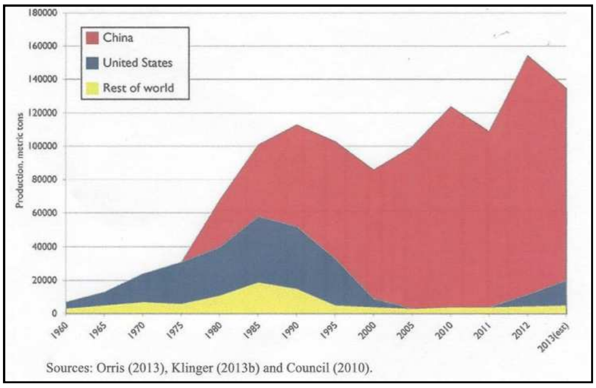
They were discovered before 1910 & produced in small amounts from monazite-bearing placers, veins, pegmatites, carbonatites & by-products of U & Nb extraction. The middle & heavy REE were available in pure form in small quantities. Since 1985, production of REE in China has increased dramatically with production coming chiefly from two sources:

1. the important Bayan Obo Fe-Nb-REE deposit, Inner Mongolia, with affinities to both carbonatite deposits and to hydrothermal Fe-O-Cu-Au-REE deposits.
2. the other major source is from ion-adsorption ores in lateritic crusts on granitic / syenitic rocks in tropical S China.

There are many REE deposits dotted around the world but few with commercial quantities and few countries are prepared to allow the highly toxic metal refining process.



USGS map of major land based deposits



Relative Production Volumes by Country

Enriched deposits of REE are rare & require specific, alkaline, magmatic conditions associated with rifts or subduction zones:

- In rifts, alkaline magma is produced by partial melting (<1%) of garnet peridotite in the upper mantle (200-600km); enrichment comes from leaching of crystalline residue.
- At subduction zones, partial melting of a subducting plate at 80-200km produces a magma rich in volatiles CO_2 & H_2O, alkaline elements & REE which are strongly partitioned into the magma.

In either case, the resultant magma rises diapirically along pre-existing fractures & can be emplaced deep in the crust, or erupted at the surface.

- REE can be enriched in deposits by secondary alteration from interactions with hydrothermal fluids/meteoric water or by erosion & transport of REE-bearing minerals.
- In tropical regions, laterite deposits occur with heavy REE incorporated into the residual clay by absorption.

REE often occur with radioactive elements so mining, extraction & refining can be a major health & safety problem. Every 1,000kg of REE concentrate generates 1,000kg radioactive waste water; 75m^3 acidic waste water; 9,600-12,000m^3 waste gas (with Rn, HF, SO_2, H_2SO_4 & ~8.5kg F).

Separation of the elements is laborious - the ores are processed with H_2SO_4 and repeated cycles of acid baths, smelting, rinsing and cooling in order to separate individual elements.

Known reserves around the globe are estimated to be:-

- China: 44.0 million MT.
- Russia: 18.0 million MT.
- Australia: 3.4 million MT.
- United States: 1.4 million MT.

Brazil: 22.0 million MT.
India: 6.9 million MT.
Greenland: 1.5 million MT.

John Stanley, Member FGS