Farnham Geological Society

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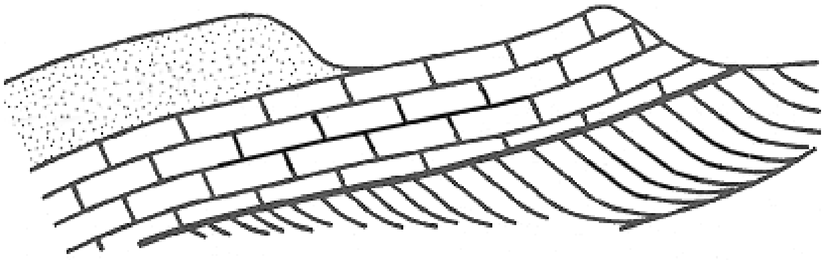

A local group within the GA

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Editorial

As you may know, Graham Williams has decided to stand back from organizing the FGS field trips. He has chosen excellent localities and varied rock types and organized the trips very well and for a long time. Graham's attitude for all to have 'a good day out' has been appreciated. I am pleased to report that Jean Davies and Christine Norgate have offered to do the bulk of the administration and to help Graham as much as possible, so check below for the list of this year's field trips.

On a new front, the committee has made the decision to organize a course as 'an introduction to geology' for members of the local Geological Societies and U3A Groups. This society formed following a similar course run under the auspices of the WEA back in 1970 and the objective of the Society is "to promote interest in geology and its allied sciences by extending knowledge of the science by such means as the Committee may from time to time determine". We have had a good response already and expect to end up with about 25 people. The exact location will depend on the final number of people wishing to come and the weekday which suits all of us, and availability at the potential venue(s). There is still time to put your name down as it will not start until March or April.

Finally, it is sad to have to report that Jill Brash, a long-standing member of the Society, died suddenly in November 2015.

Liz Aston

FGS Field Trips 2016

Date	**Details**
April 22 - 25	South Pembrokeshire **weekend** with Dr Chris Evans
May 20	Natural History Museum, London – **one-day** - a tour around the "workings" of the museum
June 5 - 6	Dudley / Wren's Nest / Kinver **weekend** - leader from Dudley museum / geopark
July 15 - 23	North Coast of Scotland for **one week** with Alan Bromley and Graham
August 7	Riddlesdown and Mole Valley, **one-day** trip, hopefully with Rory Mortimer
September 4 **OR** 11	Smokejacks Wealden section, **one-day** trip, hopefully with Peter Austen
October	Tisbury Anticline, **one-day** trip with Graham

Farnham Geological Society's *"Introductory Geology Course"*

Commencing in Spring 2016, the Society, led by its Newsletter editor Liz Aston, will be organising a structured introductory geology course, delivered within an informal atmosphere, which will include the following:

- Formation and Structure of the Earth
- Plate Tectonics, Mountain Building, Faults, Volcanoes
- Formation of Rocks, Minerals, Ores and Gemstones
- Evolution of Life and Fossils through the Eons

Meetings will be held monthly at a venue within the area: Farnham – Wokingham – Camberley (yet to be finalised). Anyone interested in attending please contact:

Liz Aston, at: **newsletters@farnhamgeosoc.org.uk** or telephone**:** **07585 - 601983**

Bits and Pieces of Archaeology,
FGS field trip to Dumfries and Galloway, August 2015

The Iron Age/Celtic farming people who once lived in SW Scotland did not build, with a few exceptions, large hill forts but chose to live with their families in small 1-2 Ha defended enclosures. We saw one of these on Big Airds Hill, where a small contour fort, with ditch and banks overlooked our hotel at Balcary Bay, near Auchencairn. We did not think we had time for a closer look and chose dinner instead.

After investigating the geology alongside Rough Firth, south of Rockcliffe, we climbed up to another small, very exposed, enclosure on Castlehill Point, a classically shaped 'sea cliff fort' defended by a revetted semicircular ditch and embankment with spectacular views of the North Solway Fault Scarp rising vertically from the sea to the E. Did people really live in these remote places with their animals or were they just refuges in times of trouble? Or were they well-fenced animal pens to protect valuable stock against predators? Who knows?

South of Creetown, with its impressive Gem & Rock Museum, we were able to spend some time looking at two remarkable Neolithic long barrows (Figure 1), the 'Clyde region' Cairn Holy chambered tombs excavated by Stuart Piggot and Terence Powell in 1949. These types of tombs date from ca. 4,200 BC and continue to be built for about 1,000 yrs, usually in the N and W in stone, and all with long narrow internal chambers constructed for internment of the dead of small separate communities.

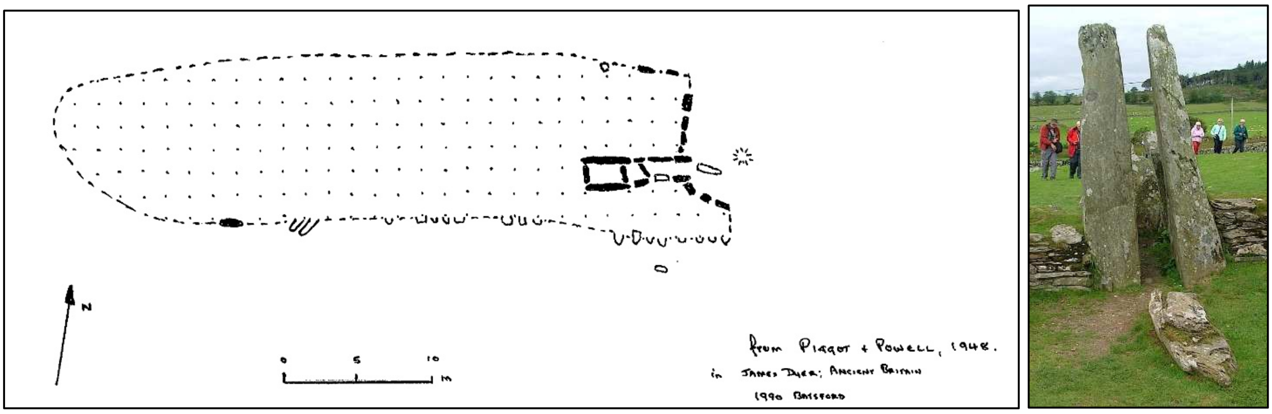


Fig. 1: Plan of Cairn Holy, above, with its long narrow opening at the end of its barrow (R).

Significantly all these chambers (Figure 2) could be revisited to add new internments and perhaps also to honour the dead ancestors, however modern dating techniques now suggest that individual tombs were used for only a few generations and that they were then sealed.

The burial chambers would probably have been covered by capstones and the whole tomb clay and earth covered although on this site only one retains its capping (Figure 3) and neither is now earth covered. The largest has evidence for a kerbstone surround to the barrow. The actual burial areas at the higher/wider end of these type of mounds generally only occupies ca. 5% of the total extent of the monuments, the unoccupied length perhaps copying the long houses of the living, but as 'a house for the dead'. These tomb styles probably originated in Atlantic and Central Europe and it is thought may have, along with their rituals, visually identified/confirmed land ownership at the time of the expansion of farming settlements in the early Neolithic.

Fig. 2: First chambered tomb at Cairn Holy with narrow chamber opening (see plan above).

Fig. 3: Second chambered tomb of Cairn Holy, with stone capping.

It is known that this site had been robbed for stone before the 1949 excavations and although few human remains were found by the excavators, a pitchstone flake from Arran and an Alpine Jadeite polished axe-head implied wide trading routes and some middle Bronze Age pottery fragments suggested later visits and the sites' continued relevance over very many centuries.

Leaving the prehistoric behind, it was particularly interesting to visit Caerlaverock Castle just S of Dumfries. Built in 1277 AD to defend the borders of the Scottish Kingdom, it replaced an earlier short-lived fortification served by a small harbour. Triangular or 'shield shaped', built of red Permian sandstone and surrounded by a double moat, it has a massive twin tower gatehouse at the apex, securely located on an outcrop of sandstone, and large drum towers at the angles, all linked by curtain walls, however here on less stable clay foundations.

Residential quarters (17th C) back on to the walls facing the courtyard. The castle is similar in form, although having only three sides, to the French/Crusader and King Edward's Welsh castles of that period.

Caerlaverock was the first Scottish castle to be attacked by Edward 1, when, short of funds, he elected to attack Scotland to seize their wealth. The castle held out for two days but was forced to surrender after its walls were battered with missiles from many 'trebuchet' machines, (a replica is displayed on site). Ultimately Edward was unsuccessful in his attacks on Scotland, his campaigns and castle building having virtually bankrupted his kingdom.

As seen now the curtain walls and towers are 15th C rebuilds. Much of the subsequent damage resulted from the siege by the Covenanters in 1644, the south curtain wall being deliberately demolished to render the castle un-defendable.

Ownership passed to the Dukes of Norfolk, in 1946 it was given into the care of the state, now Historic Scotland. It is well worth a visit.

Mike Rubra, Member of FGS

FGS Field Trip to Dartmoor in April 2015

This trip, led by Dr Alan Bromley, covered the Dartmoor granite, its faulting patterns, its metamorphic aureole and its mineralization and mining history and is described under the locations visited.

Brent Tor: A dramatic start to the field trip; a romantic little church set on top of rock which soars out of the surrounding gently undulating farm land (Figure 1).

The church was built in 1130 as a thanks giving for safe deliverance from shipwreck. There is an Iron Age fort and probably a Neolithic site (Figure 2) close by. It was rebuilt in 1319, in an age when stone was only transported short distances. The volcanic rock was most clearly seen in the arch bib and walls of the church. The architrave of the N door must have been striking. The arch, now faded, was made of pink lava (owing its colour to manganese, Mn, from the volcanic fluids in the sea) topped by a moulding of green spilite (Figure 3). The green colour was derived from algae. Given a temperature of around 33°C in the Devonian age, algae was so abundant that much would have fallen to the seabed and been absorbed in the sediment.

The surprise is that this tor is not granite. It is older than the granite (Upper Devonian/Lower Carboniferous) and is formed of submarine basic lava. Alan Bromley described a scenario where lava, intruded through or into the soft sediment of the seabed, had cooled quickly and had formed a hyaloclastite (glassy breccia). The basaltic lava extruded into a cold, submarine environment, forming pillow lavas and here too the skin had chilled quickly to a glassy skin which cracks, breaks up, and accumulates, often at the bottom of the volcanic pile as a glassy breccia, a hyaloclastite.

Other rocks within the church wall included grey cherts, a constant companion of submarine lavas, (smokers pump huge amounts of Si into the environment which precipitates out as chert)

Fig. 1: Brent Tor, Dartmoor

Fig. 2: Iron-age walls

Fig. 3: Architrave, N Door of Church

Fig. 4: Open cast mine workings (Mn ores)

Fig. 5: Contact of granite and hornfels

Fig. 6: Black tourmaline vein in porphyritic granite

The remains of open cast Mn mine was visible to the N of the church. The Mn owed its presence to the covering of shallow sea 300Ma.

Burrator Quarries and Reservoir: The Upper Car Park Quarry yielded spotted hornfels (a medium grade contact metamorphic rock) and a clean contact between the granite and country rock. Grain size was small and no chilled margin was visible (Figure 5) suggesting this was a faulted contact. There were tourmaline veins, from the introduction of boron (B) within either a metasomatic fluid or from late hydrothermal fluids, either way, the B forms tourmaline (Figure 6). Dartmoor granite contains relatively high amounts of tourmaline.

Lower Quarry: The granite displayed roughly orthogonal jointing: with vertical NNW-SSE trending joints (comparable with the Sticklepath Fault which runs across the NE edge of Dartmoor); and horizontal joints which became closer together near the top of the outcrop; they result from expansion of the granite as pressure was released when the overburden was removed by erosion (stress relief).

The Granite Dam, Burrator: The reservoir is contained by two dams, a gravity dam build in 1894 and an earth dam (Sheepstor) built in1898. The big dam is safely built from concrete faced with strong granite blocks which yielded some impressive rocks. Many contained twinned feldspars, some had brown xenoliths (Figure 6).

When building Sheepstor dam it was discovered that the granite, despite being so near was not sound but rotted (Figure 8) and feldspar had been replaced by sericite. Hydrothermal activity as the granite cooled started the decomposition; dissolved organic acid is responsible for the orange colour. Although it is rotted, the structure of the granite is undisturbed: a dyke and tourmaline seam can be clearly seen (Figure 8). An underwater earth dam was built overlying a buried concrete structure within the heavily weathered granite. The water levels of both dams were raised in 1928.

Dartmoor granite often has large crystals (phenocrysts) of feldspar (Figure 6). It comprises quartz, orthoclase, plagioclase, with biotite and lesser amounts of muscovite mica. Several types of granite occur - the contact granite, often contaminated by country rocks; the tor granites, often porphyritic; and a finer grained granite, aplite.

Fig. 7: Granite with altered feldspar (green).

Fig. 8: Heavily weathered granite, Growan Quarry, Sheepstor Dam

Fig. 9: K-feldspar phenocrysts set in med. gr. granite, Hay Tor

Higher Cherrybrook Bridge Quarry: More heavily weathered (kaolinized) granite. Weathering was particularly prevalent along the joints, suggesting a process for tor formation. However, the weathering was not limited to the joints. Here N-S joints were tourmaline free, whereas the horizontal stress relief joints were coated with tourmaline. There have been two stages to weathering: chemical weathering in the hot wet climate of the Eocene (ca. 50Ma) followed by movement in colder, recent times (Figure 6).

Mining Evidence: This was abundant – in particular, near Warren House, where tin was worked in the Bronze Age **-** shallow workings of cassiterite and micaceous haematite; ruins of processing plant at Vitifer mine, again cassiterite and micaceous haematite with quartz and tourmaline; Haytor granite railway remains, granite track, granite points, for horse drawn wagons; Widecombe waterwheel pit, copious amounts of water were required for mining and ancillary processing, here for creating gunpowder from raw materials.

Fig. 10: Horizontal stress relief jointing at Haytor

Fig. 11: Vertical joints, Haytor

Fig. 12: Fine grained aplite

Haytor: The area shows wonderful examples of the jointing systems (Figures 10, 11). Here apparently it took Alan a full 2 minutes to find something that he had been looking for, for the last 30 years – goodness knows what? Was that why he was bending over a bit of rock, almost standing on his head!

Meldon Quarry: The granite here is very pale, fine grained, and had been emplaced between metamorphosed Carboniferous cherts and shales. The presence of lithium- (Li), beryllium- (Be) and caesium- (Cs) rich minerals indicates its formation from late-stage hydrothermal fluids.

An excellent field trip despite the need for winter woollies, wellies, thermals, scarves and hot toddies.

Janet Phillips, FGS Member

Collisions, Castles and Cyclones
FGS field trip to the Gower coast April, 2015

On April 1st, on a windswept beach once frequented by a Dr Who, a Dr Williams and Jack, his assistant, summarized the structural story he had been telling us in the last few days by drawing lines in the sand, Figure 1.

The earliest rocks we saw in Gower were the Devonian ORS (mudstone, sandstone and conglomerate) eroded from the Welsh mountains of the Caledonian orogeny.

During the Carboniferous, marine transgressions deposited a sequence of limestones up to a thickness of 1,000m. At the end of the Carboniferous, the Rheic Ocean closed and a collision between Armorica-Iberia and Gondwana and S Britain formed an E-W mountain range, which was eroded throughout the Permian and Triassic.

As the Atlantic opened towards the end of the Triassic, crustal stretching formed basins into which sediments were deposited. At the end of the Triassic the sea inundated S Britain at which time the Liassic sequence of mudstone and limestone was deposited.

What evidence had we seen for this?

Day 1 Mumbles Head: At Limescale Bay fissures, filled with calcite crystals sometimes reddened by the desert sands laid in Triassic times, trend N-S; were these Hercynian fissures or the result of the extending crust in the Triassic? To the east at Bracelet Bay, the islands of the headland are the result of more easily eroded N-S faulting. Here, also, the folded limestones trend E-W (Figures 2, 3).

Fig. 1: Jack and Assistants' summarize geology

Fig. 2: Red stained Carboniferous Limestone

Fig. 3: Red staining and calcite crystallization

Fig. 4: E-W striking thrust in Carb. Lst. due to compression

Fig. 5: Flash flood deposit in wadi – large limestone boulders in sand and red mud

Day 2 At Mewslade: a very large piece of rock whose strata appear to match those of a westerly limestone exposure sits in the dry valley perhaps dropped down as successive summer melts of surface frosts eroded the rocks beneath. Discounted, was the theory that the valley results from the collapse of an underground river, as little debris from above can be seen. An example of this, further E, in Paviland Cave, where the skeleton of 'The Red Lady' was found, which, the most recent dating, puts at ca. 33,000 years BP.

North of Rhossili we saw Devonian rocks with limestone on top and a terrace, before the bay was reached. Here the question of raised beach or glacial deposits was posed and the lack of a cliff landward moved the decision to glacial deposits (solifluction).

By now our local cyclone was delivering rain as well as wind as we climbed up to summit of Cefn Bryn to look over the Loughor Estuary and the syncline of the coal measures beyond. To the north is Cil Ifor, an Iron Age hill fort/earthwork and occupied into Roman times. On top of Cefn Bryn sits Arthur's stone, an enigmatic dolmen of

Neolithic origin whose conglomerate capstone is broken; beside that, lies a large stone of different origin. Local legends of its origin abound!

Day 3: We started with a recitation of the mantra for Caswell Bay from old to young: Caswell Bay Limestone (Oolite), Caswell Bay Mudstone and High Tor Limestone. By the café the rocks dip S and across the bay dip N suggesting the limbs of an anticline. Further, towards the sea on the cafe side, triangular shaped slabs and smashed up rocks suggest an E-W thrust zone. The chaotic crumpling of the rocks being the result of the thrust decreasing the available volume in which they were bale to lie, Figure 4.

At Three Cliffs Bay, the Caswell Bay mantra persists. A N-S fault displaces the E side of the bay northwards. Here the Caswell Bay Oolite has light and dark interbeds suggesting slightly muddy conditions, also minute zigzag stylolites, indicate pressure and elsewhere we saw chert/flint material.

In the 13th/14th C the bay was swamped by sand dunes and, 12th C Pennard Castle, a ring-work castle with surrounding ditch and bank, which overlooks it, was abandoned.

Fig. 6: Small anticline in Lias beds with Carboniferous Sutton Stone thrust over Lias in a small reverse fault

Day 4 At Ogmore: the exposed surface of Carboniferous Limestone shows fossils of abundant marine life, crinoids, brachiopods, large solitary and colonial corals and we also saw a lone example of a proto-ammonite, a goniatite, which must have lived in deep warm water.

To the E was an impressive wadi, its large unsorted boulders of Carboniferous Limestone mixed with red mud and sand had been swept by flash floods and filled eroded limestone valleys, Figure 5.

Lastly, at Bad Wolf Bay we saw a long section of a Blue Lias cliff face resting on a wave cut platform of Penarth Group beds. At the opposite side of the bay, we were stunned by a spectacular section of the Lias, folded into a small anticline, and where a reverse fault had thrust the Sutton Stone (Carboniferous Limestone) above the Lias, Figure 6.

Finally the sea came and swept away the story but then that's geology for you.

Many thanks to Graham for his, patiently explained, geological expertise and to Mike and Chris for archaeological interpretations.

The tectonic history of the Alps

Summary of September lecture given by Dr Mike Streule, Imperial College, London

The European Alps are an area of great geological interest, but often the literature is awash with many terms used by local geologists, or terms specific to, and only used within the Alps. However by tracking the tectonic assembly through geological time the broad tectonic map of the Alps can be much better understood, and the local terms begin to have relevance.

A historical perspective

The history of geological endeavour in the Alps is a long and protracted one and understanding of the large-scale tectonic assembly of the Alps only came about slowly. An understanding of thrust tectonics (initially understood in NW Scotland by our very own Peach and Horne) and subsequently a recognition of large-scale nappe* emplacement allowed for a better understanding of the Alpine geology 'on the ground' in the early 20th century by the geological map makers of the day. However it wasn't until the mid-20th century when the theory of Plate Tectonics and the concept of the Wilson Cycle of supercontinent assembly, breakup and incipient orogenesis did the Alps in a broader context begin to be better understood. It is from the concept of the Wilson cycle that the tectonics will be discussed henceforth.

Pangaea

To begin with we need to go back to the Pangaean supercontinent, in part formed by the Variscan orogeny. By 300Ma granites had formed in the area of the European Varsican belt (Figure 1), and peneplaned landscape was subsequently developed. These granites (and other Variscan 'basement' rocks) 'survived' the Alpine orogeny with minimal reworking and metamorphism and are currently exposed as some of the highest granite Massifs - Mt Blanc, Pelvoux, Belledonne, Aar-Gothard, to name a few. This it is surprising feature of the Alps that the high granite massifs are of Variscan and not Alpine origin!

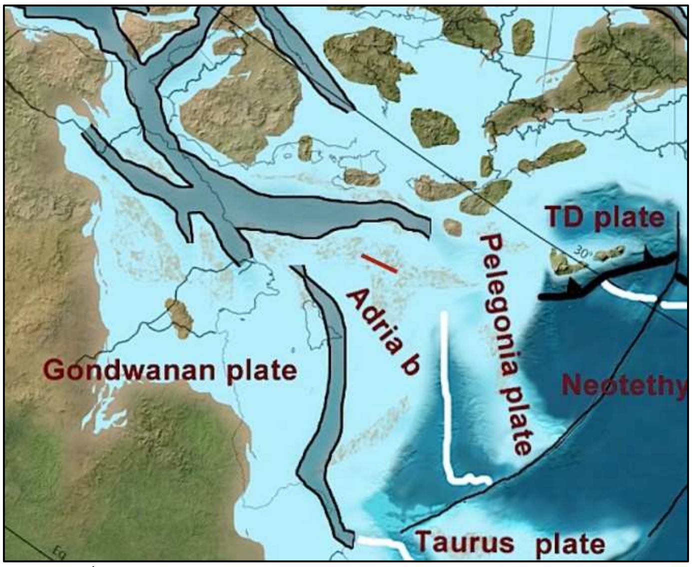


Fig. 1: [1] Position of Alpine Variscan massifs (red line), 200Ma, base Jurassic.

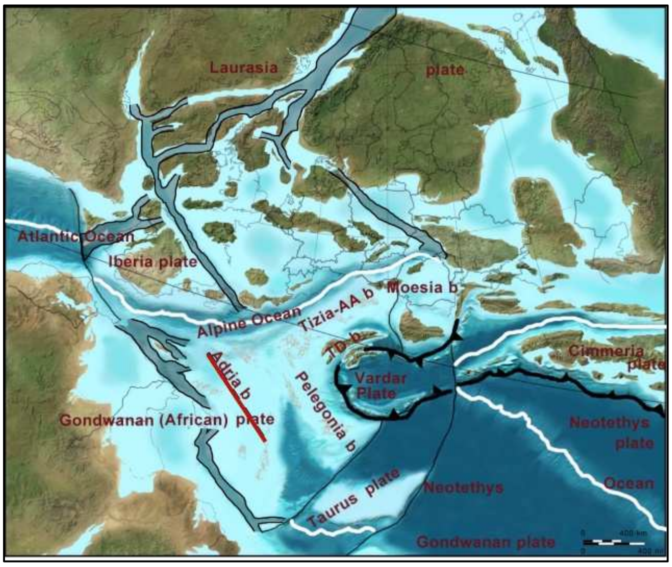


Fig. 2: Position of Italy (red line) at 150Ma, late Jurassic

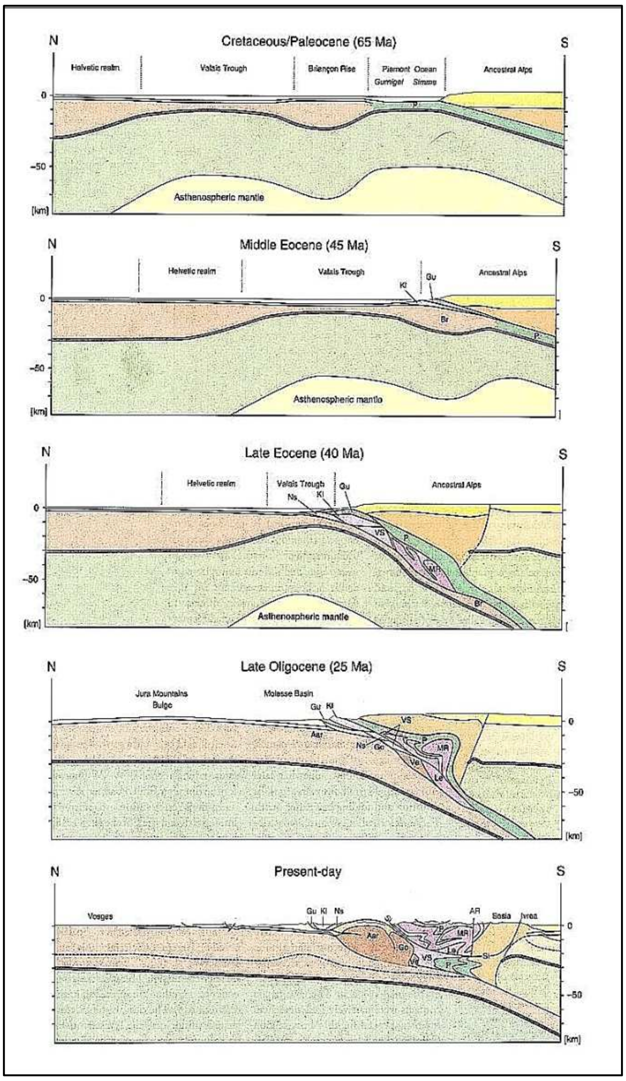


Fig. 3: Cross-sections N-S: Helvetic realm (far L) through Valais trough to Briancon rise, then Piemont Ocean to ancestral Alps (far R).
Top is Cretac'/Paleocene (65Ma); then Mid Eocene (45Ma); Late Eocene (40Ma); Late Oligocene (25Ma); base Present day.

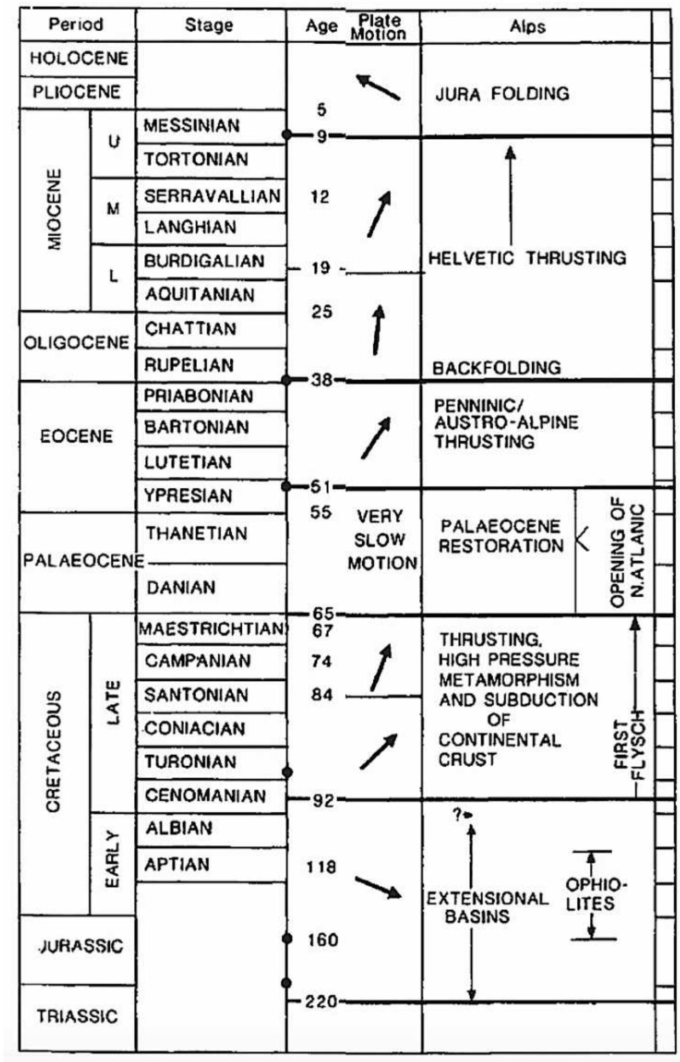


Fig. 4: African Plate Vector - Note change in vector at beginning of Cenomanian ca. 90Ma

Rifting

The peneplaned Pangaean supercontinent began to rift at around 200Ma (Figure 1[1]), and in the area of the Alps and W Mediterranean this led separation of Europe and Africa, in which Italy (named Apulia) is included. As a result a stretched continental margin developed on the S margin of Europe and N margin of Apulia. By 160Ma (Figure 2) a well-developed ocean basin had developed (the Piemont Ocean), and the S margin of Europe had developed into a more complex arrangement of basins in places characterized by sediment filled half-grabens. In the area of the French-Swiss border, from NW (the subsequent foreland to the Alpine orogeny) to SE the margin looked like this (see Figure 3):

- a shallow, warm continental shelf sea (the Dauphinois Helvetic realm, analogous to the well exposed and largely undeformed rocks of the Massif Central), then (Figure 3 LHS)
- a deeper basin, a more intensely rifted marine basin which towards the NE developed into the well-defined Valais basin, then
- an outer basin, named the Briancon High, an area of minimal rifting and shallower sea, followed finally by
- the rifted margin ‘proper’ and a dramatic deepening of the water into the Piemont Ocean.

Onset of shortening

Extension continued until 90Ma when a change in the African plate vector occurred (Figure 4) and subduction of the Piemont Ocean S beneath the Austro-Alpine margin began. Flysch was eroded off the developing mountain ranges into the deep and underfilled ocean basins of the Piemont and Valais. Extensional half-grabens now became reactivated in a reverse sense accommodating some of the shortening, as well as folding the sediments within the half-grabens. This feature is especially well displayed in the more intensely rifted parts of the Dauphinois-Helvetic realm, to the E of Grenoble on the area rising to the Col De Lauteret in the Ecrins National park. Whilst the vast majority of the ocean crust was subducted, occasionally obduction of Piemont Ocean rocks to form ophiolite sequences occurred and is particularly well exposed at Chenaillet near Montgenevre on the French–Italian border and in parts of the Queyras national park further S.

Nappe Emplacement

By 40Ma (Figure 5) the last of the ocean basins (the Valais Trough) was being subducted and the amount of convergence becomes very slow, as buoyant and less thinned continental crust enters the subduction zone. As a result of this deformation and detachment of the nappes occurs within the system, thus isolating them from their source. Shortening by way of thrusting of the nappes continued, and, in general, this occurs in a foreland propagating sequences - i.e. the ages of the faulting gets younger to the NW. By 10Ma (Figure 6) shortening had propagated a long way to the foreland (NW) deforming the Jura facilitated by and above a basal decollement formed in Triassic evaporate layers.

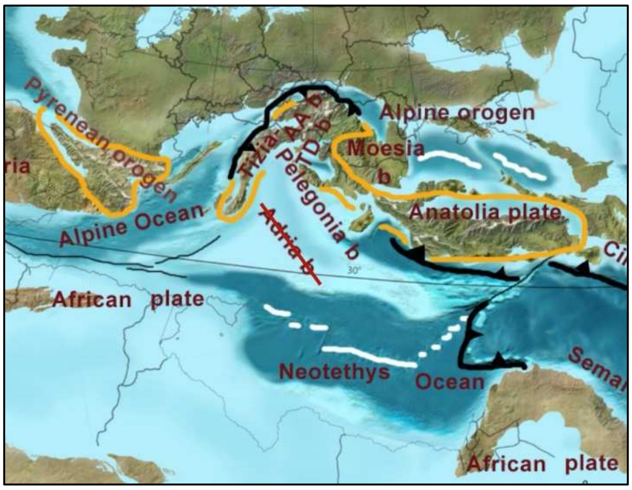
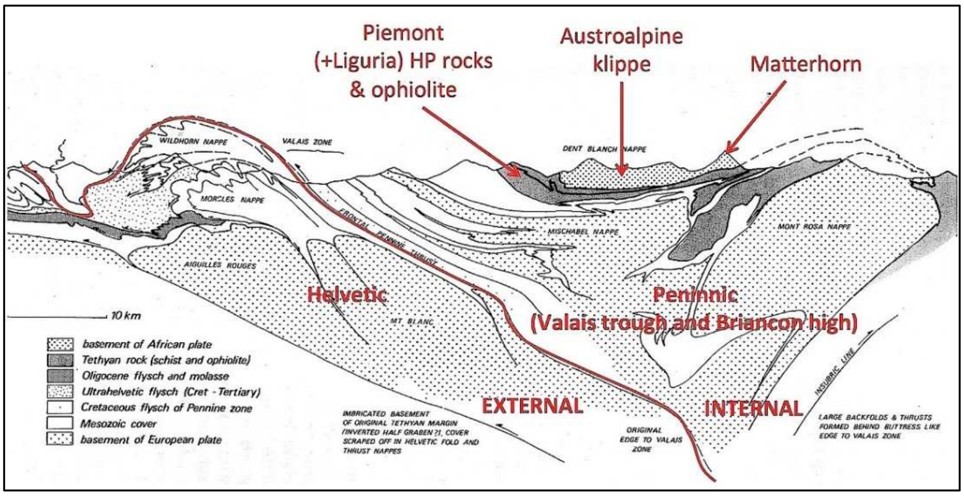


Fig. 5: Position of Italy (red line) at 50Ma, early Eocene.

Fig. 6: Position of Italy at 13Ma, middle Miocene

The emplacement within the system of nappes and the subsequent erosion has resulted in a complex surface expression for some of the units, with a number of klippen** and windows through the pile forming. Much of the current understanding of the 3D arrangement of these nappes relies on combining the surface mapping with the ECORS deep seismic surveys.



Of particular note in the W Alps are the Penninic (Valais Trough and Briancon Rise rocks, i.e. true Alpine) klippe which forms the Chablais range and the Dent Blanche-Matterhorn klippe of Austro Alpine origin (i.e. Variscan relict), which has been thrust on top of high pressure metamorphic rocks originating from the subduction of the Piemont Ocean, which in turn are thrust upon the Penninic nappes (see Figure 7 to the left).

The Penninic nappes (which originate from the Briancon Rise and Valais Trough) and rocks of Piemont Ocean and Austro-Alpine origin are often referred to the External Zones, whilst rocks of the Dauphinois Helvetic are called the Internal Zones (Figure 7 above).

The following scenes show splendid outcrops and cross sections from the Alps.

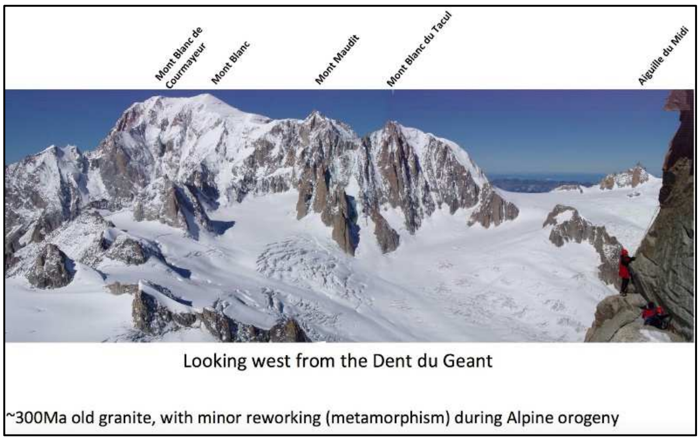


Fig. 8: Pre-Alpine, Variscan Granite of Mont Blanc

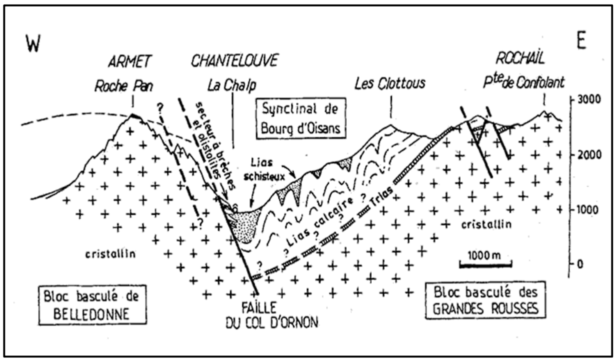


Fig. 9a: Cross section to go with photo below

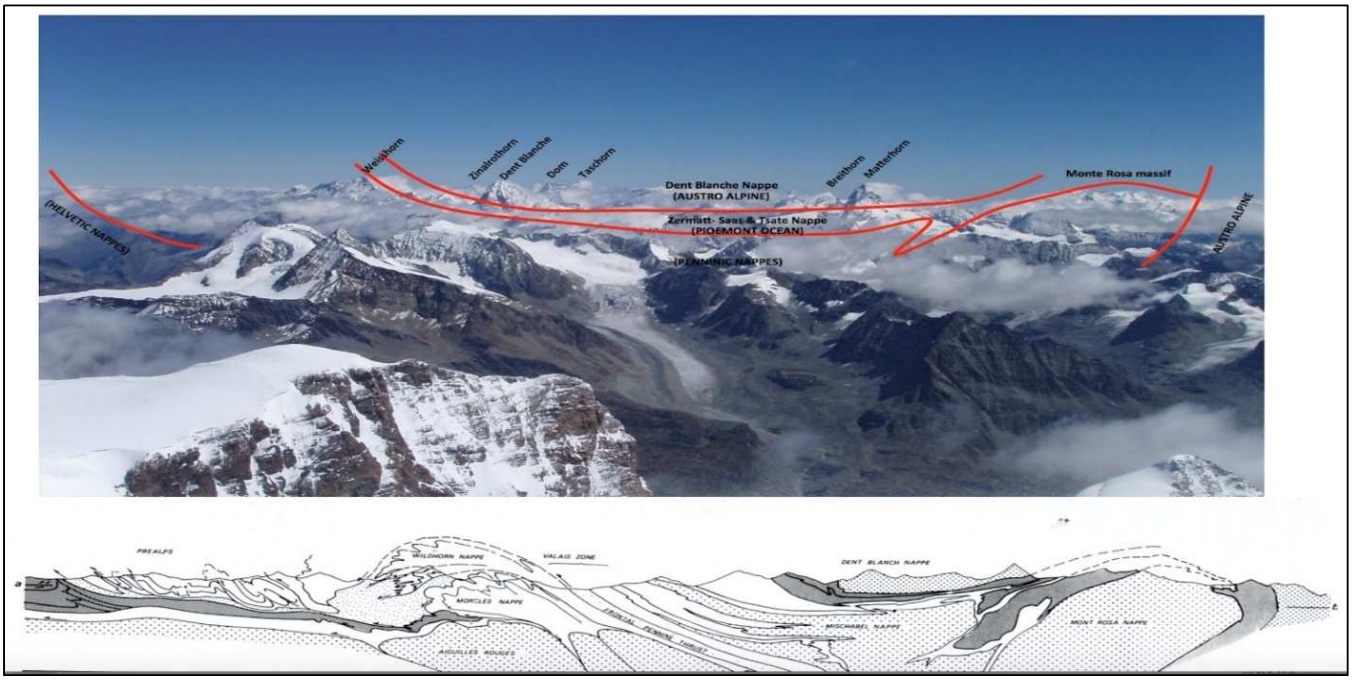


Fig. 10: View E from Grand Combin–Austro Alpine rocks thrust on Piemont Ocean rocks, thrust on Penninic Nappes (autochthonous)

Common Alpine terms

* Nappe - a large body or sheet of rock that has been moved more than 2km from its original position by thrust faulting and/or folding.
** Klippe (plural klippen) – an isolated outcrop of an older (allochthonous) rock resting on younger (autochthonous) rock, such as the end of a large nappe, the middle part of which has been eroded away.
Autochthonous – rock that has formed in its present location, i.e. is in situ.
Allochthonous – rock that has been displaced from its original place of formation, i.e. is not in situ.

References

[1] Paleogeographic Maps are from*: Blakey, Ron., Paleogeographic Map of Europe at 350Ma, Carboniferous-Mississippian, in Colorado Plateau Geosystems, Inc., go to:* http://cpgeosystems.com/eurotectonic.html

Neanderthals of the English Channel

Summary of November 2015 lecture given by Josephine Mills, Institute of Archaeology, University College, London

The Neanderthals were a complex species that dominated the cool climates of NW Europe between around 240 – 35,000 years ago. Often represented in popular media as brutish and stupid, the name ‘Neanderthal’ has been used for many years as a derogatory term for behaviour seen as regressive, such as sexism and violence. It is likely that this impression derived from early publications depicting Neanderthals as a completely separate species with no modern characteristics that could be associated with Homo sapiens. However recent research has shown that Neanderthals were not as far removed from us as previously thought, in fact modern individuals with a non Sub-Saharan African descent are likely to have between 2-4% Neanderthal DNA, suggesting a degree of mixing between our two species. Additionally we also have increasing archaeological evidence for complex behaviour within Neanderthal groups such as use of home bases, pre-determined lithic technology and burial of the dead.

Anatomically Neanderthals have a series of different features to modern humans, for example a barrel shaped rib cage, pronounced brow ridge, enlarged nasal aperture, and shorter, stockier, long bones with large muscle attachments. It has been suggested that these skeletal qualities were related to cold climate adaptation, with the shorter stature and chunkier frame reducing surface area, thus heat loss. Moreover the barrel shaped rib cage and enlarged nasal aperture have been linked to thermodynamic regulation, effectively warming air before it enters the body. These biological capabilities support the image that the Neanderthals were very well adapted to their niche-environment. Additionally features of their material culture also contribute to this idea, e.g. Neanderthals possessed an advanced form of stone tool creation called the Levallois technique. Synonymous with the Middle-Palaeolithic this method allowed the user to predetermine the size, shape and thickness of the artefact they were knapping from their raw material. This innovation greatly improved the efficiency of flint knapping, reducing waste material and producing better blanks from which to make tools.

However the debate about Neanderthal behaviour is never static, new discoveries and the re-examination of old theories mean that the field is constantly in flux; e.g. recent finds such as modified eagle claws have been used to suggest that personal ornamentation may have been a feature of the Middle-Palaeolithic. Contrastingly the re-examination of old evidence such as the famous flower burial at Shanidar Cave has suggested that the pollen thought to be indicative of modern internment practices actually derived through natural processes rather than symbolic.

These are just two examples that show how difficult it is to make a definitive judgement on Neanderthal symbolic behaviour. However something incontrovertible is the bioarchaeological evidence that Neanderthals cared for their sick and injured, a behaviour that is so inherently human-like it very much contrasts their image in popular culture. We know of skeletons that have suffered major trauma yet show healing, demonstrating that the individual lived past their accident; there is even evidence of one individual with severe cranial injuries who was probably rendered blind, yet survived to old age; we can only assume with help of another individual or group support.

Neanderthals were widespread across the English Channel, a region stretching between Britain and France W out over the Continental Shelf. The Channel itself was created when a giant lake, formed by the glaciers of the Anglian cold stage, breached and created the Channel River or La Fleuve Manche. This in turn formed a highway between E and W Europe but separated France and Britain. The evidence of Neanderthals we find in the Channel is in the S part of the Manche region, on the coasts of Brittany and Normandy but also preserved on the Channel Islands, which sit on the shallow Continental Shelf of the Armorican Massif.

Geologically the Channel Islands represent remnants of a much older igneous landscape, made up of granitic deposits; this more durable rock withstood erosion and the Tertiary deposits that cover much of the Channel floor eventually surrounded the islands. The topography of the Continental Shelf and its position above sea level meant that for much of the Ice Age the area was not submerged as it is now, e.g. it would have taken a drop in sea level of less than 20m to join Jersey to the French Coast. Therefore during cold stages of the Pleistocene, when glaciations locked seawater into ice, the Channel Islands were instead raised plateaus forming part of a much wider Neanderthal landscape. Interestingly we know that flint, the raw material preferred by Neanderthals, was not widespread across the Channel and is not indigenous to the Channel Islands. It is instead restricted to small pockets of Cretaceous deposit between Jersey, Guernsey, Alderney and Sark.

We see evidence of Middle-Palaeolithic Neanderthals across the Channel in the form of both big home base sites, such as La Cotte de St. Brelade in Jersey, Mont Dol in Brittany and Le Rozel in Normandy, and smaller cave sites like La Cotte à La Chèvre. Here we find archaeological deposits containing stone tools but also faunal remains and archaeologically significant sediments. Finds have also been made in the inter-tidal zones of the Channel Islands including a mammoth tooth located to the SE of Jersey near Seymour Tower. Additional submerged archaeological deposits such as those of the Cap Levi headland in Normandy point to the diverse Middle-Palaeolithic landscape that would have once existed across the Continental Shelf that is now submerged.

The main focus of our research project is La Cotte de St. Brelade, an extremely archaeologically rich set of deposits spanning approximately 240- 40Ka. Located on the S coast of Jersey this mega-site lies within a t-shaped ravine system and has been subject to excavation for over 100yrs. Our work has focused on re-interpreting the excavated stone tools but also re-assessing the site within its regional context both off and onshore. At this stage of the process we have curated over 94,000 artefacts excavated by Charles McBurney of Cambridge University in the 1960-70s, prior to his untimely death.

Through this work we have begun to understand how Neanderthals lived at La Cotte during different periods of the Middle-Palaeolithic and have observed some unique adaptations. For example many of the tools we analysed were re-sharpening flakes, a method used to render a new working edge, highly indicative of re-use and recycling of material. Additionally we have very small tools, which appear to have been worked until they were too difficult to use. Both these factors point to a high level of conservation of raw material, suggesting that the Neanderthals there did not have unlimited access to flint – their raw material of choice. Interestingly we have also noticed that in some layers at La Cotte, particularly layer 5, there is a wide variety of raw material represented including quartz, quartzite and glossy sandstone. This again points to the idea that the Neanderthals were having to adapt to a lack of available material, we believe that this could be linked to rising sea-level covering the known Cretaceous deposits containing flint. Conversely it has also been hypothesized that falling sea-level, and thus reduced proximity to the inter-tidal zone, may have restricted secondary beach deposits of flint, again removing raw material from the Neanderthal's subsistence area. Thus here we see a unique adaptation, which adds to the idea that as a species Neanderthals were able to overcome challenges and change their behaviour to include coping mechanisms.

La Cotte is probably most famous for its definition as a 'mammoth drive', this hypothesis derived from research done by Dr. Kate Scott in the 1970s on the two large bone heaps found at the site. These collections of bones were located in layers 3 and 6, preserved by fine wine blown sediments - they are some of the only large bone remains we have from the site. As the accumulations contained almost solely woolly rhino and mammoth the idea of a mass kill event was proposed. For example the Neanderthals would have used the natural shape of the headland above the site to drive large mammals to their deaths in the cave below. However a recent paper published by our research group has re-evaluated this theory. This research focused on the offshore topography of the La Cotte Valley suggesting that the mammoth and rhino may have alternatively been corralled upwards into the site. A survey of the land above the site revealed a new partially empty fissure that would have impeded driving mammoth off the cliff, instead the animals would have fallen into this fissure before they reached the edge. Although we cannot prove the theory at this stage these advances sum up what our research is about – shedding new light and perspectives on this site and the archived excavation material whilst highlighting the importance of the landscape around the Channel Islands and hopefully in future linking the La Cotte Neanderthals to those of Normandy and Brittany with the aim to figuratively explore the submerged landscape of the Continental Shelf.

For more information about La Cotte:

Callow, P., & J. M. Cornford (ed.).1986. La Cotte de St. Brelade 1961-1978: Excavations by C. B. M. McBurney. Norwich: Geo

Scott, B., Bates, M., Bates, R., Conneller, C., Pope, M., Shaw, A., Smith, G. 2014. A new vies from La Cotte de St. Brelade, Jersey. Antiquity. 88: 13-29