Hertfordshire Geological Society

NEWSLETTER, WINTER 2012

THANET, SATURDAY JUNE 11, 2011

By Linda Hamling

Having enjoyed a hot drink at Sam's Bar after our journey from Hertfordshire, we joined Haydon, our leader for the day, on the beach at Dumpton Gap (TR 397665) near Broadstairs. Only two type sections ('golden spikes') have been internationally accepted for defining the various Upper Cretaceous stage boundaries. The Chalk exposed in the cliffs at Dumpton Gap is mainly of Early Santonian age (83-86 Ma), and has been proposed as the type section for the base of the Santonian Stage (= top of the Coniacian Stage). However, the relevant international committee decided that sections near Cognac in southwest France were more suitable, perhaps because the local libations attract more geologists than visit Thanet.

Haydon recounted the large amount of research on the English Chalk during the 1980s. In particular, Rory Mortimore studied the sequence of the South Downs and Nick Robinson that of the North Downs, of which Thanet is the eastern extremity. Consequently, two sets of stratigraphic nomenclature developed independently. In 1987 Rory was asked to correlate them, and his detailed sequence of chalk, flint and marl horizons for southern England was adopted in the late 1990s.

We began by looking at the major marker band known as the Chartham Flint, which is equivalent to the Mitcheldean Flint of the South Downs. Beneath it is the Pegwell Inoceramid Band, which had been proposed as the golden spike for the Coniacian/Santonian boundary. In the Chalk, the bivalve *Inoceramus* is a useful indicator of age, as it was widespread and its juveniles were planktonic whereas the adults settled on the sea floor. At Dumpton Gap the base of the Santonian is indicated by the lowest occurrence of the Inoceramid *Cladoceramus undulatoplicatus*.

Crossing the bay, which occurs along a fault, we found the Bedwell Columnar Flint Band on the north side of Dumpton Gap (fig. 1). Because of the northward dip, progressively younger beds are exposed as you walk northwards along the coast from Dumpton Gap. The Bedwell flints are paramoudra, having formed around vertical burrows. They are associated with various types of fossils, as bioturbation led to churning, allowing the influx of siliceous material and the formation of flint. The Bedwell and Chartham Flints can be traced across the whole of southern England, and the Inoceramid-rich bands are found throughout Europe and even extend into the USA, though not necessarily in Chalk but in chronologically equivalent marls.

Fig.1. Haydon with good example of the Bedwell Columnar Flint Band. [Photo: Lesley Exton]

The calcareous foraminifera in the Chalk indicate the depth of water in which they lived. With increasing depth of water, there was a decrease in temperature and carbonate became more soluble, so that less was available for ornamentation of their tests. With an increase in water depth during flooding events, the foraminifera are thus smoother and less ornamented. Subtle changes in ornamentation of the Chalk foraminifera can therefore be used to indicate changes in level of the Chalk sea. Foraminifera are also as widely distributed as the Inoceramids, and are as useful as stratigraphic markers.

From Dumpton Gap we drove to Joss Bay (TR 400702), where we enjoyed a picnic on the beach. At Dumpton Gap, we had been able to see Whitaker's 3-inch Flint Band high in the cliff, but at Joss Bay it is more clearly exposed in the low cliff as an unbroken continuous tabular flint. The fairly regular periodicity of the major flint bands is perhaps explained by Milankovitch cyclicity, with changes in climate resulting from cycles in the earth's orbit around the sun.

Above Whitakers 3-inch Flint Band we saw the Barrois Sponge Bed, which represents an important change in sedimentation. Below this bed there are flint bands, such as the three we had seen, but above it there are none. The Barrois Sponge Bed also marks the upper limit of the unornamented foraminifera *Stensioeina granulata polonica*, suggesting from this horizon upwards the sea level was falling rather than rising. In Chalk beneath the floor of the North Sea, where the water was deeper in the graben, the same species extends to higher horizons. The Barrois Sponge Bed is used as the base of the Middle Santonian. Large Inoceramids occur below it in the Lower Santonian Chalk, but above we saw echinoids forming Rowe's Echinoid Band and then the Peake Sponge Bed. In a well in Chislehurst Caves in northwest Kent, the Barrois and Peake Sponge Beds have united to form a hardground, the intervening beds having been lost in a condensed sequence. This has probably resulted from slower deposition or erosion because of uplift of the seafloor over the London-Brabant massif.

At about the same level as the Peake Sponge Bed we first began to find the stemless crinoid *Uintacrinus*. Also in the cliff 10 metres or more above our heads Val spied a very impressive specimen of the large ammonite *Parapuzosia* (fig. 2).

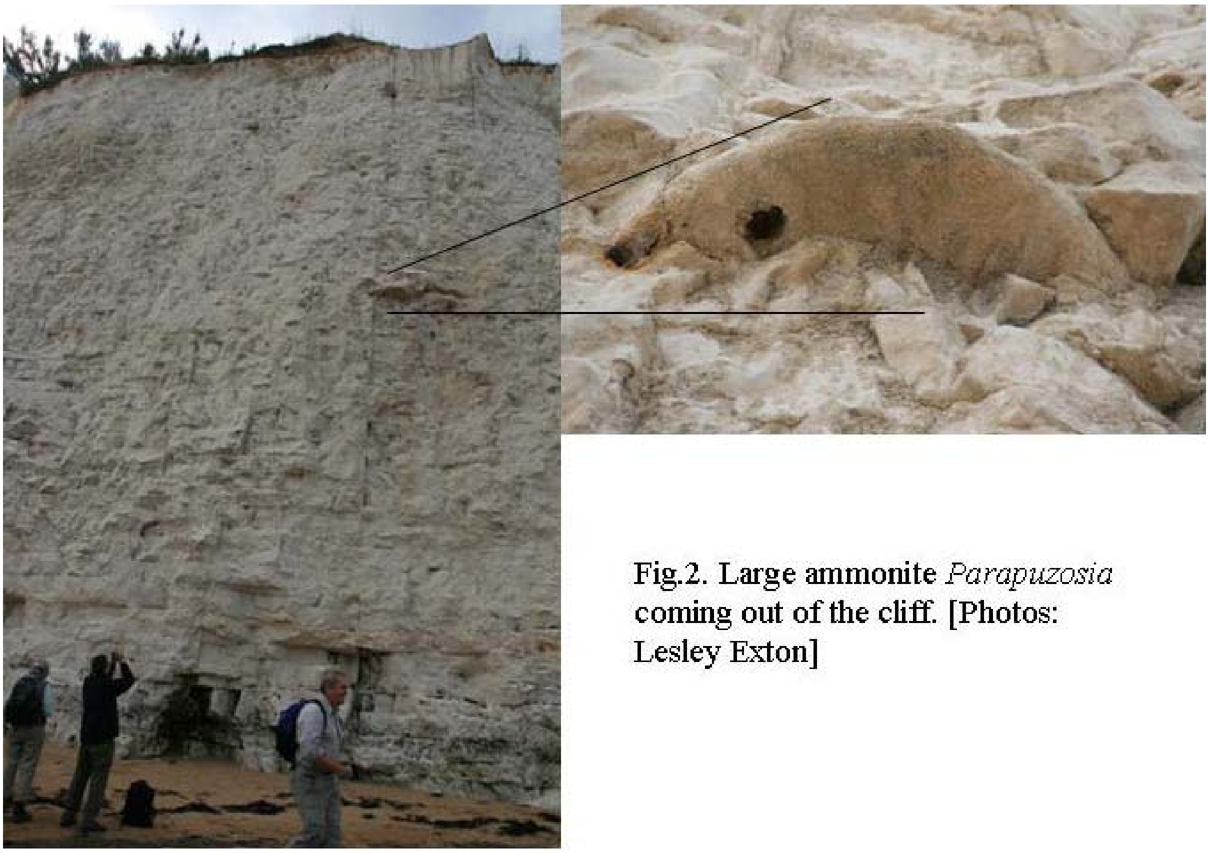

Fig.2. Large ammonite *Parapuzosia* coming out of the cliff. [Photos: Lesley Exton]

As we walked northwestwards into Kingsgate Bay, marine erosion had exploited joints in the Chalk to produce numerous caves, which are reputed to have been used by smugglers. Changes in the joint systems between Chalk formations may reflect small changes in Chalk lithology. The Chalk in this area is free of flint, which is typical of the Late Santonian Chalk. Chalk of this young age is preserved in the central part of the London Syncline and rarely seen elsewhere in southern England, where it has been removed by erosion before deposition of the Palaeogene beds.

We then returned to our cars at Joss Bay, having had a lovely day exploring the fascinating Upper Chalk succession of this part of east Kent, thanks to Haydon.

THE CHALK OF NORMANDY, SEPTEMBER 22-26, 2011

By Linda Hamling

For the first night (Thursday, September 22nd) of our long weekend studying the Chalk of the Dieppe-Entretat region in Normandy, we stayed at the White Hart in Lewes, where we met our leader Rory Mortimore. This inn is famous as the location where Thomas Paine proclaimed his revolutionary theories. The next morning our coach, driven by the obliging Rob, picked us up, and we drove to the ferry terminal at Newhaven going through the Cuilfail

Tunnel on the way. At the ferry terminal we queued surrounded by vintage cars, whose charms excited us all.

After a very calm crossing accompanied by the odd gannet, we drove to the western end of the bay in Dieppe. Unlike the English E-W coastline, which runs oblique to the dip and strike, the N-S French coast displays a dip section of the Chalk, which makes examination of the sequence easier. First we saw a hardground developed above three prominent flint bands. Rory explained the process of flint formation. In the Late Cretaceous, sea level was up to 300 m above present; this is much higher than would be possible at present, even if all the glaciers on the current earth's surface were to melt. The very high Cretaceous sea levels are thought to have resulted from active volcanic ridges, which raised the sea floors beneath the widening oceans. Reaction between the volcanic rocks extruded on the ridges and the seawater released large amounts of calcium and silica into solution. Precipitation of these two components dominated the sediments being deposited, as inputs of detrital sediment from low-lying arid land areas were very small. In the reducing conditions near the sea floor, any sulphate in solution was bacterially reduced to sulphide, some of which would have combined with iron in solution to precipitate iron sulphide as pyrites (FeS_2). However, as the supply of iron was limited (because of the small inputs of fine detrital sediment), much of the sulphide formed H_2S, and this migrated upwards into more oxic waters. At the boundary between the sulphate-reducing and oxic waters, the H_2S was re-oxidized to sulphate, liberating hydrogen ions (H^+) as a by-product. The hydrogen ions created locally acidic conditions, reacting with sulphate to form sulphuric acid. The acid locally dissolved carbonate in the Chalk sediment, releasing bicarbonate ions, and these initiated precipitation of silica from solution to form flint. Calcite dissolution and silica precipitation thus proceeded simultaneously, and any insoluble (non-carbonate) particles in the Chalk sediment were incorporated into the flint. The silica was often precipitated in animal burrows because the burrowing introduced oxygen to a lower level in the sediment, and this decomposed organic matter in the burrows thus increasing the local concentration of bicarbonate ions compared with adjacent unburrowed chalk. Where the sea was deepest, insufficient oxygen could reach the sea floor for production of bicarbonate ions and no flints were formed.

The Bray Axis extends from the bay at Dieppe across the English Channel, and has resulted in erosion of the Chalk by scouring currents to produce a channel, which was subsequently infilled with onlapping sediments.

Moving further west we found the Seven Sisters Flint Band. This is less permeable than the Chalk above, and as a result karst cavities have formed above it to produce an extensive cave system, often with fluting on the cave walls and roves (fig. 3). Water penetrating down fissures above has carried Palaeogene sands and loess from near the surface, sorting and redepositing them as colourful sediments in the cavities above the flint band.

On the wavecut platform, we searched for fossils in the hardground. The occurrence of *Echinocorys* and *Micraster* suggested that it is close to the boundary between the Seaford and Lewes Chalk Formations. Rory also found a magnificent *Platyceramus* lying loose on the beach and a *Spondylus* preserved in a flint. A local man was kind enough to bring us a marcasite (FeS_2) nodule, but could not be persuaded that it had not fallen from the sky as a meteorite. In the evening of the first day dinner was taken on the lively quayside in Dieppe.

Fig. 3. Sediment-filled karst features along the impermeable Seven Sisters Flint Band. [Photo: Lesley Exton]

On the following morning (Saturday, September 24th) we drove through the pretty countryside of the Caux Plateau of Normandy to Fécamp, passing a sarsen on the way. In this town there are many houses with walls built of flints beautifully dressed into perfectly squared blocks. This local industry is celebrated on a roundabout with a sculpture of a man and his carthorse collecting flint from the beach. Such collection is now forbidden, as the flinty beach protects the Chalk cliffs from erosion.

At the base of the cliff at Port de Havre-Antifer petroleum port, we saw pebbles with green glauconitic coatings within the basal Chalk. This is the Gaize Rock, the French equivalent of the Glauconitic Marl at the base of the Chalk in England. It represents the first transgression of the Chalk sea extending onto an area of land known as the Caux Block. The Gault Clay beneath was hidden from view. Above were flint bands forming nodular branching horizons, which were obviously infilled burrows. These flints are much older than any in England, where the first flints appear at the top of the Grey (Lower) Chalk. In England flints are absent from the marly Chalk, which has no zone of burrowing and any soluble silica is taken up by detrital clay minerals. The sequence at this locality is highly condensed with several hardgrounds, and is equivalent to the West Melbury and Zig-Zag Chalk formations in southern England. At a higher stratigraphic level, equivalent to the Holywell Formation in England, there are no flints.

Three sarsen menhirs guarded the entrance to the path down to Le Tilleul Plage, north of the petroleum port. Here we found *Mammites nodosoides* in the chalk at the base of the cliff. This ammonite indicates the Lower Turonian Stage. We also found *Mytiloides*, indicative of a less oxidizing environment, in a zone characterized by large foraminifera (*Globigerina*), indicating Chalk deposition in deeper water as a result of a global rise in sea level. Intraclasts were scattered within the Chalk, a feature that can be traced at this horizon across Europe into eastern Germany. The clasts were not bored, indicating an absence of benthos due to less aerobic bottom conditions in the deeper water. Because of uplift of the Anglo-Brabant Platform, there are no Lower Cretaceous deposits in this area, apart from the Aptian (Lower Greensand), which rests directly on Upper Jurassic Kimmeridge Clay.

Moving on we found the Antifer Hardgrounds, which replace the Plenus Marls deposited in the deeper water of the main Chalk basin, as in southern England. The hardgrounds contain intraclasts that have been bored by a diverse fauna including *Inoceramus pictus*, indicating more aerobic bottom conditions. Higher in the cliff we could see scoured channels with slump features and mounds of biological origin. We then picnicked on the beach, enjoying a wonderful air display by terns diving into the sea for sand eels.

After lunch we examined a horizon with trace fossils including Zoophycos feeding traces picked out by flint deposited in burrows. However, progress through an arch into the next bay was then thwarted by another (real) air display about to begin. But the official who barred our way did allow us to go a little further to see the dolomitized chalk in the spectacular cliff. Here we could see the toe of a synsedimentary slump structure along which a cave system had developed and the Chalk had been hardened. The slumping had resulted from irregular uplift and tilting of the Caux Block. We were also attracted by pretty pink manganiferous flints.

Unable to continue because of the air display, some of us walked over the cliff top to Entretat to see the cliffs made famous in paintings by Monet. On the way we were able to observe the wonderful display, which was performed by, amongst others, the Blue Diamonds, the French equivalent to the Red Arrows here. In a very crowded Entretat, we saw another arch in this superb cliff. That evening we returned to the restaurant on the Dieppe quayside. Earlier in the day there had been a running race broadcast on television, with yet more crowds of people watching the event.

On Sunday (September 25th) we drove to Puys, which is in the main basin of Chalk deposition and shows all the Chalk marker beds in the order one would expect to see them in southern England. The Lewes Chalk Formation is an orange-stained nodular Chalk overlying a grey marl band, the Lewes Marl, which is volcanic in origin. Below that were scattered Lewes Tabular Flints, a band that can be traced across the whole of the Anglo-Paris Basin, and then the Breaky Bottom Flint (fig. 4). Sheet flints were seen at various stratigraphic levels because they had migrated along shear planes. At Puys this sequence is 20-30 m thick, but in Wiltshire, Berkshire and Hertfordshire over a platform where the sea was shallower, it is condensed into 1 m of Chalk. The volcanic ash incorporated into the marl seams is thought to have originated from a mid-Atlantic Ridge volcano. The ridge would have been much closer in the Upper Cretaceous, when the Atlantic was narrower. The frequency of the flint bands was possibly related to Milankovitch cycles, which caused changes in monsoonal climatic belts, runoff from land areas and sedimentation in the Chalk sea. The Late Cretaceous climate was a hot greenhouse climate, and the sea at least 5^{o}C warmer than today.

We then examined blocks of chalk fallen from high in the cliff. These contained dark grey streaks within lighter grey burrows, which are traces of Zoophycos, bacterial feeders invading the organic matter-rich burrows.

Fig. 4. Examining flints in the Lewis Chalk Formation and on the beach. [Photo: Lesley Exton]

The blocks came from the Cuilfail Zoophycos Beds. Rory found a tubular flint, which was the outer wall of a burrow. Its inner surface showed scratches produced by the animal responsible.

As we walked on to St Martin Plage, we could see the Penly Nuclear Power Station, one of four along the north French coast. The Plenus Marls occur beneath it, overlain by a much expanded sequence of Holywell Chalk with no flints and intraclasts without borings indicating a low diversity fauna. However, there were abundant *Mytiloides* shells and we saw a giant *Mammites nodosoides*. There were numerous fractures, which occur right across the basin, though with different styles in each Chalk formation.

The cliff at Criel Plage has Lewes Tabular Flints at its base, with the Lewes Marl above. The flints are overgrown by a second phase of silicification, and in the marl we found *Mytiloides* and *Micaster* spp. We lunched *al fresco* at the excellent Le Coq Hardi in Criel, a seaside village lying in a river valley exploiting a fault. After lunch we were able to paddle through freshwater streams bubbling up from impressive springs in the wave-cut platform formed of Lewes Chalk. Some were brave enough to taste the water and declared it very good. A team led by Rory has monitored the cliffs here for their stability using geophysical methods, which have shown that each Chalk formation has its own characteristic system of fracturing. Wave energy transmitted through the wave-cut platform exacerbates cliff collapse, and can be monitored using geophones, which measure acoustic emissions. Using this system one cliff collapse was predicted 48 hours before it happened.

Sadly it was now time to catch the ferry home. But as we left Dieppe we were rewarded by a panoramic view back to the cliffs we had explored. We had enjoyed a fabulous weekend, thanks to Rory and Haydon and the lovely weather.

KENSWORTH AND TOTTERNHOE, SATURDAY, JULY 16, 2011

By Haydon Bailey

On a typical summer day, i.e. horizontal rain driven by a south-westerly gale, a hardy group of stalwart members gathered at the National Trust Centre on Dunstable Downs. It was so wet outside that we decided to stay indoors for another coffee – and then another. Just as we were thinking it wasn't really a good day for fieldwork, a hint of blue came through the otherwise grey skies, and we decided to chance it. So we trooped off down to the nature reserve within the bounds of Kensworth Quarry (TL 011200). But our optimism proved to be unfounded, as the rain returned with renewed vigour for the rest of the morning.

The Chalk face in the nature reserve had recently been thoroughly cleared of vegetation by Anne Williams and her colleagues of the Bedfordshire and Luton Geology Society, and the results were clear to see. The Caburn Marl (= Reed Marl) was clearly visible at the eastern end of the face, and its disappearance near the western end was explicable at last as the result of minor faulting. Only with the face completely cleaned was it possible to see this for the first time – a clear example of what a little site geo-conservation can achieve. We spent the rest of a very wet morning searching for fossils in the Chalk Rock above the marl.

Having had our fill of the Chalk Rock, most of us retired to our bolt hole (the National Trust Centre) for a good lunch, very proud of ourselves for persevering through the weather, however John went home to St Albans to change his wet trousers. A little more drizzle after lunch wasn't going to put us off now, and we set off for Totternhoe Quarry (SP 9822), which is now managed by the local wildlife trust. At this site, the Totternhoe Stone within the Lower Chalk is well known as a submarine channel deposit. As the sun came out we spent some while searching for fossils among the many blocks of clunch and stone in the old quarry. Numerous ammonite fragments and their aptychi were found. So the day proved a success despite our initial misgivings about the weather.

CHAIRMAN'S CONCLUDING REMARKS

By Haydon Bailey

The day at Kensworth and Totternhoe clearly illustrated the impact of a little coordinated work cleaning up sites and the added value this can bring to understanding their geology. It is always much better if you can actually see the rocks! In Hertfordshire we are not blessed with large expanses of geological exposure, and those we do have rapidly become overgrown and degraded. Currently many of our important RIGS sites are under the management of the Hertfordshire & Middlesex Wildlife Trust, although the original reason for their conservation was geological (e.g. Hitch Wood and Barkway Chalk pits). If the Trust works on these sites at all, they only touch the vegetation and don't clean the faces for fear of damaging an important aspect of the geology. Conversely, we don't clear the vegetation, as we regard this as the Trust's responsibility! There is a clear need for a cooperative approach, in which the Trust attack the undergrowth and we spend time cleaning and re-exposing what makes these sites important in the first place – the geology. John Catt and I are soon meeting the new chief executive of the Trust to establish a fresh spirit of cooperation and bring the geology back to where it should be – at the centre of everyone's attention.