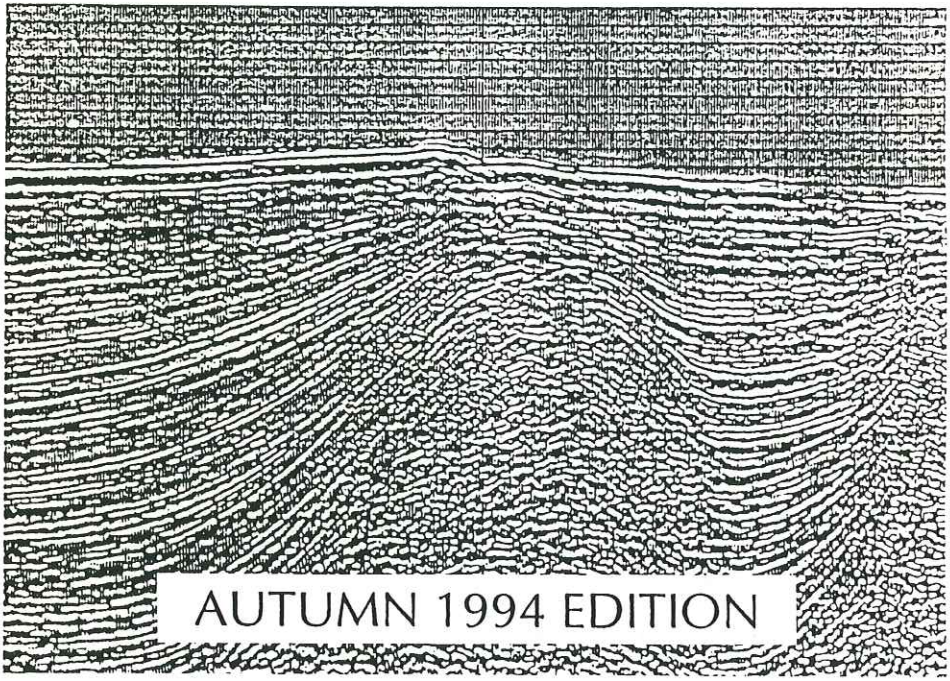
CHARNIA

LEICESTER

LITERARY AND PHILOSOPHICAL

SOCIETY



AUTUMN 1994 EDITION

THE NEWSLETTER OF

SECTION C (GEOLOGY)

LEICESTER LITERARY & PHILOSOPHICAL SOCIETY
GEOLOGY SECTION
WINTER PROGRAMME 1994/5

All meetings held on Wednesdays at 7.30p.m. in the Council Room of Leics. Museum & Art Gallery, unless otherwise stated. Coffee from 7p.m. Entrance fom rear of Museum, Princess Road West.

1994

October 5th John Martin - a visit to the galleries and stores of the Museum & Art Gallery

19th Dr Martin Clarke "Volcanoes and Lakes in the Kenya Rift"

November 2nd Dr Andy Saunders (Leicester University) "Fire and Ice: drilling off the southeast Greenland Margin"

7th (Monday, 7.30p.m.) Joint Parent Body Meeting: Prof Ansel Dunham (Leicester University) "Natural History and Utilisation of Clays"

16th Dr Peter Floyd (Keele University) "Old Worlds - New Worlds: a geological tour of the solar system"

30th Dr Frank Moseley (Birmingham University) "Geological field mapping in the Lake District and elsewhere (Spain, Arabia, etc.)

December 14th Members Evening - Bring Your Own - specimens, pictures, food,drink

1995

January 18th Dr David Siveter (Leicester University) "The Origins of Pelagic Ostracods"

February 1st Prof Brian Windley (Leicester University) "Geological tales from Mongolia"

11th (Saturday) Vaughan College Saturday School "Geology from Space"

15th Simon Timberlake (South Eastern Museums Service) "Seven years on the road with a peripatetic travelling geology curator - a travelogue with a difference"

March 1st Members evening - short presentations of slides

15th ANNUAL GENERAL MEETING Chairman's address by Dr Roy Clements "Looking at Fossils - part II"

JUDKINS: A LAST LOOK by M.J. LeBas.

On Saturday morning, June 11th., around twenty-five keen types drawn mainly from Section C and the OU Geological Society, drove in convoy past the land-fill area to the more interesting parts of Judkins Quarry in Nuneaton. This was a special field excursion: Judkins Quarry was set to cease the extraction of stone to become wholly devoted to land-fill. For the last one hundred years, Judkins has been visited by geologists who have recorded many important features, principally in the basal Cambrian unconformity and the igneous activity. Therefore, this last look at Judkins was organized before it disappeared under a sea of Warwickshire's waste. John Colby made the arrangements, negotiated the indemnities and 'marshalled the troops' and I conducted the geological excursion.

The excursion was timely because of the controversy that had arisen during the previous twelve months. That is, that the Brand Group sediments may be Cambrian and not Precambrian. One key issue is the age of the markfieldite (a diorite) seen in Charnwood apparently cutting Brand Group sediments. At Judkins a similar-looking markfieldite dated at 602 Ma (zircon/U-Th data) intrudes the Precambrian volcaniclastic Caldecote tuffs and is unconformably overlain by Cambrian quartzites. Could we confirm these field relations in Judkins? We did. We found metre-sized, well-rounded boulders and many smaller ones down to pebble-size, marking the unconformity at the base of the Hartshill Quartzite (of presumed Cambrian age) and although most boulders are of Caldecote Volcanic rocks, some are of markfieldite - thus confirming the age relations. We also saw and collected superb but minute crystals of barite, sphalerite and various copper sulphide and sulphate minerals, in voids in and below the conglomerate. Good exposures of the markfieldite were then seen, also some of the 'Blue Hole' rocks which are altered basalts that intrude, as pipes and dykes, the bedded Caldecote Volcanic tuffs. The latter are probably the equivalents of the volcanic tuffs of Charnwood Forest. The bedding of the Judkins tuffs was not easy to see, but that in the Triassic sandstones at the top of the quarry caused debate as to whether they were subaerial or water-lain. It turned out to be the latter. The day ended with discussion on the quality of wines produced on volcanic soils, such as the Caldecote tuffs might have produced had there been vines in that era and -hey presto..! A bottle of Californian wine was produced and presented to a nonplussed leader, who muttered thanks to the gallant geological band present and commented that it was a great shame that this would be the last geological visit to the site. In the twenty five years that he has led parties to Judkins, he had seen the complicated geology in the quarry gradually being interpreted and expressed the hope that the top section of the quarry might be preserved as an SSSI.

On the following day, Sunday 12th June, a reduced band gathered in Hartshill and wound their way to Grange Farm Quarry, otherwise known as Manabel's Quarry when not called Jee's Quarry. There, in the SSSI, we saw splendid spheroidal weathering of the jointed Caldecote massive crystal tuffs below the basal Cambrian unconformity. At a lower level in the exposure, we picked out cross-bedding, graded bedding and water-escape structures in the tuffs, indicating that they were water-lain and thus appropriate to island arc volcanism. Basaltic and lamprophyric dykes and sills were also seen, sketched and photographed.

After a pub lunch at the Anchor (geologically immortalized in 'anchorite' - a name coined in 1898 for a patchy rock extracted from another Hartshill quarry) the party high-tailed it to Bradgate Park to compare the rocks already seen with

corresponding Charnwood rocks. Inspection of the markfieldite by Bradgate House in the Park left little doubt that it could be correlated with that seen the day before in Judkins. The next question of trying to correlate the Stable Pit quartzite with the Cambrian quartzites in Judkins could not be answered; all quartzites look alike anyway and no detailed heavy mineral analyses have yet been made that might give a correlation. The Sunday afternoon ended with a search for identifiable pebbles in the conglomerate which outcrops near to the Hallgates entrance of the Park and as blocks in the walls around Cropston Reservoir. The hope was to find pebbles of markfieldite, like those seen in Judkins, which would have proved that the Brand Group sediments were deposited after erosion had exposed an earlier-intruded markfieldite. We did not, and the present interpretation that the markfieldite (dated at 602 Ma) intruded the Brand Group rocks remains. This conflicts with the recent discovery of trace fossils in the Brand Group slates, which are said to be Cambrian.

M.J.LeBas.

THE LEICESTER CITY TRAIL

On the evening of 25th. March, 1994, eleven members and a budding geologist in a push-chair gathered at the Post Office in Bishop Street to undertake the City Stone Trail, led by Liz Bellamy (on the history of Leicester and its buildings) with Mac Whitaker (on the geology of the city's building stones). Mac began by dissuading anyone from buying his 'Building Stones of Leicester' from the museum, as the guide is now rather out of date: he is starting to prepare an up-dated edition.

After describing the main types of rocks used in building and the criteria for choosing suitable durable materials, Mac directed the party to several examples of igneous rocks in the Town Hall Square area (De Lank granite, 'Emerald Pearl' and 'Blue Pearl' larvikites, Peterhead and Shap granites with xenoliths and a fine-grained black granite from Sweden or South Africa). Liz outlined the history of the square, Leicester's former cattle market (hence Horsefair Street) and the Town Hall, built in 1876 and imcorporating typical well-sorted Ketton Oolite. This has been corroded by leakage of acidic water from the peat in window boxes, now removed. Millstone Grit was introduced at the Reference Library and shelly Portland Oolite at the Citizens' Advice Bureau. Fenwick's has regrettably painted over its handsome Verde Fraye fascias (a green brecciated serpentine rock with calcite veins) though its presence was noted where some paint had flaked off and in the main entrance opposite the sturdy pillar of Shap and Peterhead granites. Red Triassic sandstones are incorporated above the entrance. Westmoreland green slates (actually grey) with a pleasant 'riven' (i.e. cleaved) surface were studied on hands and knees at Tipo in Market Street. Opposite, Tarratt's has been re-faced in 'Blue Pearl' larvikite and a handsome Italian white breccia called Arabescato from the Jurassic near Lucca. The Roman Stone from the Cretaceous near Trieste, carved with fur-bearing animals on what was the National Fur Company's shop and the similar Nabresina limestone of the somewhat shrunken British Gas offices are still there. at the corner of Market Street, a most attractive stone has been used for re-facing the premises now occupied by one of Leicester's McDonald's restaurants. Mac (no relation) waxed eloquently on the handsome grey and white banded travertine from Rapalino, from

the WNW of Pisa, known as silver travertine. Intrigued by what was going on outside his restaurant, the manager emerged; satisfied by the explanation and newly knowledgeable on his shop front, he invited the party to return for a drink when the trail had been completed.

A short diversion down Horsefair Street to the entrance of the Norwich Union building revealed fine panels of the elusive Verde Fraye (or similar - there are many varieties of green and white breccias from the Jurassic-Cretaceous of the Val d'Aosta on the Franco-Italian border). Crossing Horsefair Street with its Croft diorite kerbstones, we came to the County Rooms, which Liz explained had been intended originally as a hotel. Built of Hollington Stone (Triassic, from near Stoke-on-Trent and well known for its use in both the old and the new Coventry Cathedrals) it shows cross bedding, slump structures, weathering and 'face bedding' of the pillars. At Natwest, exhibiting an unpolished Aberdeen granite overlain by Portland Oolite, Liz pointed out the tendency for banks and other civic-type buildings to enhance their image by building grandiose establishments.

At the Cathedral, Liz commented on its history and Mac pointed out the purple Swithland Slate headstones, whose delicate carving showed minimal weathering. The Cathedral's main structure is of Millstone Grit but the spire is of the lighter-weight Lincolnshire Limestone. Renovation of the of the outside Millstone Grit fabric has been done unaesthetically with blocks of Clipsham and other eye-catching light coloured stones. The Guildhall is built of rough blocks of South Leicestershire diorites (probably from the quarries at Croft) and is roofed in a distinctive way with small pieces of Swithland Slate at the ridge, grading to larger slabs at the bottom. Liz spoke on the history of the Guildhall and compared its timber-work with Wyggeston's House, which we visited next and where she explained the importance of the High Cross as the early centre of Leicester, where a four-pillared structure stood for sheltering the tradespeople in inclement weather. Liz said that one surviving pillar had been erected in the Market Place and that we would see it later.

On approaching the Clock Tower (Liz again) Mac was delighted to find more Silver Travertine on the front of McDonalds High Street restaurant. This showed less coarse banding but better typical travertine growth structures than the facing we had seen in Market Street.

On our way to the last locality in the Market Place, we saw small pieces of metaquartzite used on two shop fronts. Finally, the remaining High Cross pillar was examined. It is coarsely shelly and Mac hazarded his last guess of the evening, which was that it could be made of Clipsham Stone.

Mac Whitaker and Liz Bellamy.

CHARNIA REVISITED - Revisited.

As a sequel to last February's Vaughan College symposium, "Charnia Revisited", a party of 22 people assembled at Bradgate Park on Saturday 13th August, to revisit Charnia.

The programme was to examine at first hand the geological structure of the northern part of Bradgate and the trace fossils to be found at this most important site. Dr. Helen Boynton led the group and within minutes of entering the Park we were transported back some 600 million years to a Precambrian scene; warm shallow sea accumulating oozing sediments . . . being bombarded with volcanic bombs and ash falls from the nearby Bardon volcano.

We were soon examining the base of the Bradgate Formation at the Sliding Stones Crag. This is composed of sliding or slump Breccia topped by coarse tuffs which are well bedded and probably formed in a submarine environment. In places the bedding was contorted and several "V" shaped disturbances were described as the possible impact sites of volcanic bombs. In the absence of any obvious residual "bomb" material this was hotly debated and the cause remains open for further imaginative speculation. Evidence of volcanic activity was however clear, the patterns being characteristic of submarine sediment and pyroclastic flows.

Moving uphill towards Old John we examined a further outcrop of the same Breccia with slate fragments clearly visible within a matrix of coarse tuff. Evidence of faulting was also examined with some lateral displacement in relation to the Sliding Stones Crag.

Further uphill, just below Old John, we paused to absorb the magnificent view (or was it the recover our breath!). The sunlit landscape revealed the geological diversity of the area. Jurassic out towards Billesdon Coplow to the East, Triassic to the West with Quaternary sand and gravels to the North. The Caledonian at Mountsorrel and the Carboniferous towards Coalville were there to be seen with Cretaceous gault clay* in evidence in the valley below where we stood.

Behind Old John we found ourselves in the remains of a stable; part of the old horse racing track which once operated in the Park. It was easy to imagine the ghosts of the horses and stable lads of those bygone days but these were soon replaced by the ghosts of a much older species when Helen asked us to find two ovoid disc fossils in the almost vertical exposure which formed the back wall of the old stable. Sharp eyes soon found a somewhat indistinct specimen of "Cyclomedusa" with Trevor Ford and walking stick acting as direction finder for the less well sighted. A further even less distinct specimen was found before we moved over to the Memorial Craggs to find some better examples.

(* ? Ed.)

Here again we encountered slump Breccia located to the south, just below the Memorial, dipping at an angle of 60 to 70 degrees, with laminated fine to medium grained tuffs. With an almost reverential air, Helen pointed out our first frondose organism,"Bradgatia linfordensis" and we were subsequently introduced to what were clearly old friends and affectionately called, 'the Boss', 'the Splodge','Whirligigg' and the 'Pineapple'. The light was not perfect but the sun appeared intermittently to allow us fleeting glances of these strange forms. Apparently, siliconecasts have been made which under laboratory lights reveal more detail than the originals 'in situ'.

Discussion ensued on their likely form and origin. W ere they medusoids ? Did they float or were they attached into the sediment with a holdfast like today's waterlilly? Similar specimens have been found in Newfoundland, Australia, Russia and Namibia prompting a world wide debate on these questions, but apparently the jury is still out!

After 3 hours it was time to disperse, one couple having travelled from Kent. It was time to reflect on what we had seen and experienced. For me it was the perfect sequel to the symposium. The weather had been kind to us and Helen had proved herself to be an excellent guide. Trevor Ford had provided some additional information often promoting debate by suggesting alternative possibilities. The only disappointment from the afternoon was clear evidence of hammering (by persons unknown) on some of the exposures. We had seen only part of the Park and perhaps Helen or Trevor could be persuaded to complete the picture for us next year.

Keith Smithson.

First meeting of the 1994-5 Winter programme...

The Geology Section has been meeting at the Museum since 1849, when the LLPS collection was handed over to the Town Council. In celebration of this 145th. anniversary (!) members are invited to a rather special first meeting of the 1994-5 Session.

John Martin, Keeper of Earth Sciences, will briefly describe the job of museum geologist before conducting members on a guided tour of the newly re-opened geology galleries. The displays include a larger selection from the Museum's rich collections than have been on show for many years, in an exhibition which covers petrology, mineralogy and palaeontology, common and rare, large and small. refreshments will be served and there will also be an opportunity (numbers permitting) to see 'down in the basement' where the laboratories and reserve stores are situated.

Preview of talks in our winter meetings programme up to Christmas 1994

All meetings will take place on Wednesdays in the Council Room of the Museum & Art Gallery at 7.30p.m., unless otherwise indicated. The entrance is at the rear of the Museum, on Princess Road West. Coffee will be available from 7p.m.

October 5th **Visit behind the scenes at the Museum and Art Gallery**
John Martin, Keeper of Earth Sciences at the Museum and Art Gallery, has kindly arranged this evening for our section. The plan is that after an introductory talk there will be guided tours - a unique opportunity, not to be missed!

October 19th **Volcanoes and Lakes in the Kenya Rift**
The present day floor of the Rift Valley in Kenya is dominated by a chain of large caldera volcanoes of Recent age which often have associated geothermal activity. Also present are a number of lakes varying from fresh to ultrasaline in composition, the latter hosting the largest known concentration of flamingo. Some of the volcanoes and lakes contain extractable resources in the form of steam, carbon dioxide and soda as well as being components of the famous natural laboratory that is the Rift Valley.

Martin Clarke graduated in 1964 from Manchester Univ. Attracted by the possibility of travel he then completed a research degree on East African carbonatites based at Leicester under the guidance of Mike LeBas and Diana Sutherland. From 1968-78 he worked in Kenya and Swaziland under secondment to the Geological Surveys of those Govts. Between 1978 and 1983 he worked as part of the BGS team which completed the mapping of Northern Sumatra, an area larger than England and Scotland. Shorter periods in Botswana, Bangladesh and Ecuador followed as well as 2 further years in Kenya. In 1990 he retired from the BGS and has since worked as a self employed consultant, mainly in Indonesia.

November 2nd **Fire and Ice: Drilling off the southeast Greenland Margin**
Andy was co-chief on Leg152 on the SE Greenland Margin last September-November, and was previously on Leg121 of the Ocean Drilling Program, and Leg64 of its successor, the Deep sea Drilling Project.

The title alludes to the contrasting geological environments and rock types that they investigated. During the early Tertiary, approximately 60 million years ago, the SE Greenland margin was the scene of large-scale eruptions of basalt as the continent began to split apart. One reason for the eruption of basalt was the presence of a hotspot or mantle plume in this region; this plume now underpins Iceland. Much later, the margin was glaciated; we discovered glacial dropstones embedded in sediments some 8m.y. old, which suggests that glaciation in S Greenland began much earlier than expected.
Andy will present some of the results from the two months' drilling, and include in the talk aaspects of the Ocean Drilling Program. He will also mention some of the problems encountered in drilling in the southern Denmark Strait at that time of year!

November 16th **Old Worlds - New Worlds: a geological tour of the Solar System**
With the advent of space probes (Voyager, Mariner, Magellan) and soft-landers, earth science has expanded into the study of our near solar system neighbours - the planets and their satellites. The first detailed pictures of the surfaces of the inner planets revealed a multitude of features largely produced by meteorite impact and ancient volcanism - largely "dead, old worlds" - very different to the active surface of the earth. The numerous satellites of the outer gas giants told a different story, some with surface being reworked and remodelled now by a number of processes. What are the processes that have shaped our planetary neighbours and what can we learn fom studying their surfaces about their development and composition?

Peter Floyd was a first Geology honours graduate of Leicester Univ. in 1959. He went on to complete his Ph.D at Birmingham in 1962. Currently a Readeer at Univ. of Keele, Staffs., his main research interest is in the geochemistry and petrology of volcanogenic rocks in relation to their origin and tectonic environment. He has carried out research in W Pacific Ocean (via Ocean Drilling Programme, Leg129), Turkey (ankara melange ophiolites), Poland (L. Paleozoic volcanics) and SW England/German sectors of the Variscan orogen (basaltic and rhyolitic metavolcanics).

November 30th **Geological field mapping in the Lake District and elsewhere**
Frank Moseley needs little introduction, particularly to students of geology for his supportive works on mapping. As well as the Lake District, he will be covering exotic locations such as Spain and Arabia amongst others. He will also be bringing a selection of maps and photographs.

December 14th **Members Evening**
Our annual DIY session! You are invited to bring along specimens, photographs, stories etc. Help willingly offered if you want to find out more about your specimens. Food and drink contributions help make this a convivial gathering....

JOINT PARENT BODY MEETING

November 7th (MONDAY) **The Natural History and Utilisation of Clays**

Clays were one of the earliet raw materials to be used; this has expanded and continued to the present time. In this lecture the nature of muds and mudrocks, which contain not only clay minerals but also many others will be explored from the point of view of the properties of the materials which make them useful. This will lead to an account of recent work in the Geology Dept. in Leicester into swelling clays, into brick and refractory raw materials, and into applications of such work in *archaeology* and *forensic science*.

Professor Ansel Dunham is currently Professor of Industrial Mineralogy and Head of the Dept. of Geology in Leicester University. He came to Leicester from Hull University following the Earth Sciences Review, bringing with him the M Sc course in Industrial Mineralogy. His interests lie in the application of geology to useful purposes, particularly in the non-metallic field. An unexpected spin-off from his interests followed the kidnap and murder of Julie Dart in 1991 when he used his techniques for forensic puposes with brick "fingerprinting".

LEICESTERSHIRE RIGS - PROGRESS

I recently had cause to produce a brief report on the state of play with RIGS (Regionally Important Geological /geomorphological Sites) in Leicestershire, and, knowing the great interest in this scheme amongst Section members, I thought a brief summary here would be appreciated. RIGS being of more purely local interest than SSSI's, are of lesser conservation status, and whilst (unlike SSSI's) they do not have any statutory protection, local authorities have agreed to consider the conservation interest of these sites when they come to consider planning applications, etc. (see Graham Stocks' article in last autumn's *Charnia*).

In Leicestershire (including Rutland), our local RIGS Scheme comes loosely under the umbrella of the Leicestershire Geologists' Forum (which is itself less an organisation, more an informal means of communication between geologists working in the county). In practice, to date, the work has been largely undertaken by the Earth Science Section of the Leicestershire Museums and Art Galleries Service: Dr. Arthur Cruickshank was employed for this purpose, on a two year contract (now completed), for which 50% funding was received from Leicestershire County Council.

1. The primary site selection phase has now been completed, and whilst the current list is not sacrosanct, there are currently no new sites being added to (or deleted from) this list. The number of RIGS recognised for the county is 104.

2. Full evaluation of all the sites has been completed. The "interest " of a RIGS can be varied (purely scientific (across the whole spectrum of geology), educational (at various levels), amenity, scenic, history of science, archaeological/industrial archaeological) and multifacetted. The evaluation allows us to take into account all these various factors for an individual site to produce a semi-quantitative/qualitative assessment.

3. A consolidated list of these RIGS has been produced, and is available to *bona fide* interested parties . However, it is not yet available for publication, and will not be until the notification processes (see below) are complete.

4. Whilst all the sites have written details, full-blown, individual site reports will only be produced for a selection of the RIGS, and to date only a few have been done.

5. Notification of (and more importantly, consultation with) owners/occupiers of RIGS sites is ongoing, slowly. The owners of all the sites (mostly major sites) in industrial ownership have been notified, but only a small proportion of the owners/occupiers of the usually smaller sites in "private" ownership have been notified. This latter is a delicate, but extremely important task.

6. The County Council has been notified about all the Leicestershire RIGS sites, as from December 1992. The District Councils, and the City Council have also all been notified about all the RIGS sites in their respective areas. Already, these notifications have produced dividends by way of consultations relating to planning applications. It really does work!

7. District reports have been produced which summarize the geology and give a selection of the less sensitive RIGS information for four of the District Council areas. These are for Charnwood, Harborough, Hinckley and Bosworth, and Melton Districts respectively. These reports are currently available only on disk, but could be published if funding were available. A similar report for the whole county is also available.

8. The Leicestershire and Rutland Trust for Nature Conservation has been provided with a copy of the consolidated list of Leicestershire RIGS. Whilst the Leicestershire

Scheme has not yet formally sought help from the Trust, such a request is likely to be forthcoming shortly, when time is available to properly formulate it. Undoubtedly, there will be areas where Trust help will be essential. Indeed, resources at the Museum are becoming so increasingly stretched, such that if the local RIGS Scheme is not to founder, or at least if we are to get full value from it, the Forum , our Section, and other local interest groups will have to become more positively involved. Exactly how this will work is still uncertain, but I suspect the Trust will have a pivotal role to play. English Nature (in its coordinating role for RIGS schemes throughout the country) has provided advice during the establishment and implementation of our local RIGS Scheme. It has also provided a grant of £300, which has been used to defray the cost of consumables.

9. We do not yet have a complete picture of the number of sites on our list that are requiring proactive conservation. Currently there would seem to be at least about 12 sites requiring management in the form of development, cleaning, etc.

10. Ms Gill Weightman of the Earth Science Section at the Museum, is the current contact for details about Leicestershire RIGS, but John Martin and I should be able to supply general information.

Roy Clements

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The drilling of high temperature, high pressure wells in Northern Pakistan.

by

Alan M Hay.

As a Petroleum Geologist I am often assigned to remote locations at short notice, literally anywhere in the world. The locations tend to be harsh and uncivilised, however they present an opportunity to visit areas few westerners will ever see.

Having been one of the last westerners to be evacuated from the civil war in Yemen, I was waiting eagerly for my next assignment, and was pleasantly surprised when my name was put forward to assist in the drilling of a well in Northern Pakistan. Personally I have always harboured a desire to see the Himalayas and the North West Frontier, and was thus looking forward to the adventure. The proposed well was located south west of Islamabad (the newly created capital of Pakistan) in the tectonically active mobile belt of the Himalayan foothills.

One of the reasons I was picked for this particular job was my experience in high pressure and high temperature wells.

In tectonically stable sedimentary basins the rate of deposition is such that sediments accrete gradually allowing vertical dewatering to proceed without hindrance during lithification. The pore fluids contained within the pore spaces is said to be normally pressured, and this pressure gradually increases with depth at a more or less constant rate. Likewise the geothermal gradient associated with stable areas also exhibits a gradual increase with depth, and can be predicted with reasonable accuracy.

However in tectonically active areas, sedimentation rates tend to far exceed those of "Normal" sedimentary basins, and often permeable sand bodies quickly become sealed by impermeable clays, preventing the vertical migration of entrapped pore fluids during compaction. As the sand body is buried deeper and deeper under an accumulating sedimentary pile the pore fluids are subjected to greater and greater pressure, and are thus considered to be abnormally pressured. A drill bit penetrating such an abnormally pressured sand body will likely experience an influx into the well bore of the highly pressured fluids, occasionally with disastrous consequences, a blow out may even result. A further problem associated with tectonically active regions is that thrust faults can bring highly pressured rock bodies, that had previously been buried at depth, into a normally pressured sequence, close to the surface.

The high pressure expected in the well I travelled to is a direct consequence of the continual northward movement of the Indian Sub-Continent into the Asian land mass. It is this high pore fluid pressure which is thought to be responsible for the great lateral displacements achieved on thrust planes, the thrust gliding along on a cushion of abnormally pressured fluid almost like the way an avalanche glides on a cushion of air. The thrust sheets associated with the thickening of the continental crust in the region of the Himalayas are both numerous and interspersed between normally deposited sediments. In terms of drilling in areas such as this one of the main difficulties is how

to drill through normally pressured sediments but still take into account the presence of these highly pressured thrusted sections.

When drilling wells heavy chemical liquid muds are pumped down the bore hole to counteract the formation pressures contained within the rocks natural pore space. In a normal sedimentary basin the formation pressure profile of the well will show a gradually increasing trend with depth, and thus the muds used can be adjusted gradually to take this into account, i.e. made heavier. In zones in which abnormally pressured sections occur there will often be a sudden and dramatic increase in pore pressure. If this exceeds the hydrostatic pressure of the mud contained in the bore hole an influx may result, often termed a kick. A further complication with kicks occurring is that the invading fluid is often at a much lower density than the mud within the bore hole and consequently dilutes the bore hole fluids thus decreasing the hydrostatic pressure even further. This allows even greater volumes of fluids to enter the bore hole and obviously taken to its ultimate conclusion the bore hole can be totally evacuated of drilling fluid resulting in a blowout. The force associated with blowouts and kicks is measured in pounds per square inch (psi) and can be tremendous. Sufficient in certain documented instances to expel the entire drill pipe from an 18,000 feet deep bore hole and throw it hundreds of feet into the air. This pressure can occasionally be in the region of between 5 - 20,000 psi and has been known to pick up the equivalent weight of two express trains and throw them hundreds of feet. As if this isn't enough the pore fluids themselves can cause massive hole and drilling problems purely by their chemical composition. One of the most dangerous fluids contained within pore spaces is sour gas, or hydrogen sulphide(H_2S). This gas is so dangerous and noxious that if 0.0007% occurs in air, and is inhaled in this concentration, then death can occur almost immediately. The gas also has other unwanted properties, such as, it's highly explosive in air, and will cause steel to become brittle and snap if it is left exposed to the gas for a sufficient amount of time.

The well in Pakistan was expected to encounter all of these problems, and more, and had been previously drilled three times but never completed successfully. The well is the oil company's final attempt to complete the drilling of a potentially lucrative hydrocarbon bearing structure.

During my first trip to Northern Pakistan two influxes, or kicks, occurred, high density fresh water flowed from the formation and expelled some of the contents of the well bore. The resulting measures taken to bring the well back under control, took in total a week and a half to complete. As the well is expected to take at least nine months to drill, and considering that the truly horrendous pressures and hole problems likely to occur are towards the bottom of the hole, my future trips may be eventful to say the least.

I am due to fly back to Pakistan shortly, and wonder just what lies in store...

GEOLOGY FROM SPACE

I remember, as schoolboy, seeing the first television picture of the Earth from space. It was in the 1950s and the picture detail wasn't all that clear, except for the curvature of the horizon and the boundary between Earth and atmosphere and atmosphere and the vacuum of space. In the past forty years, photography and other kinds of imaging from space-borne platforms have progressed almost beyond belief. As I write this article on a sunny morning in April, the space shuttle Endeavour is orbiting the Earth in preparation for landing in California after taking radar 'pictures' of the Earth, revealing a mass of geological detail, such as minor fault lines. Since February, a tiny satellite called Clementine has been orbiting the Moon, photographing the lunar surface in visible, infra-red and ultraviolet wavelengths, revealing geological details not previously observable. These are just two current examples of a lengthy series of space probes designed to provide a wealth of information, much of it of a geological nature.

The spin-off from the politically inspired 'space-race', 'cold-war' and 'star-wars' technology has provided the geologist with a wealth of tools and techniques for both the remote sensing of our own planet and other bodies in space. For example, the tiny satellite Clementine is to be sent off to rendevous with an asteroid in August. We can even send craft to our close neighbours in space to physically collect and retrieve geological samples.

The concept of space geology (I will stick with the sometimes inapt prefix 'geo-') is not entirely new. Spectroscopy is a technique whereby specific wavelengths of light (and infra-red and ultra-violet too) emitted by a hot body give away the presence of chemical elements. In 1868, Sir Norman Lockyer, matched the emission wavelengths of sunlight with elements known on Earth. For example, the spectral lines of iron, sodium, hydrogen, magnesium, calcium and so on were easily identifiable, as if these elements were being fingerprinted. This wasn't new: W.H Wollaston had done the same thing sixty-six years earlier. However, Lockyer found one set of absorption lines in the spectrum of sunlight which he couldn't match with any element known on Earth to science at that time. Although Lockyer christened this unknown element 'helium', it wasn't identified until 1895 when Sir William Ramsey isolated the gas from the atmosphere. A truly extra-terrestrial discovery and one in the eye for the geochemists! This prime example of remote sensing pre-dated the Space Age by almost eighty years.

However, even before this, extraterrestrial information was pouring onto the Earth's surface at the rate of tons per day, even though the exact nature of meteoric material wasn't appreciated until about the same time that spectroscopic studies were being carried out...

Well, that was written as the beginning of a piece on what might be called 'space geology', started some six months ago and put on hold. At that time of writing it wasn't certain that we would have a speaker for the subject in November or indeed the Saturday School on the subject in the New Year. It seems odd that we know more about the topography of the surface of Venus than we do about parts of the Earth's ocean floors. It is fantastic that a geochemist can sit in front of a VDU and prospect for metals in the Scottish Highlands by using satellite imagery, without moving from an office in Keyworth! There is so much raw data about the Solar System, gathered as a result of space-borne exploration, that if there was a moratorium on space flight now, there would be enough material for interpretation for researchers to last for several years hence...

Graham Stocks

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