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AN INTRODUCTION TO KARST RESEARCH AND CAVING IN ROMANIA

by

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ABSTRACT

This paper gives a brief overview of Romanian caving and karst research, The information was acquired during a visit to the country by members of the Society in the summer of 2007.

INTRODUCTION

Equidistant from the pole and the equator, Romania is one of central-eastern Europe's largest nations with a population of 22 million. Bordering Moldova, Bulgaria, Serbia, Hungary the Ukraine and the Black Sea, it occupies an area of some 237,000 km^2. The terrain of Romania is roughly split equally between mountains, hills and plateau and planes. Not only is the landscape of this country rich and varied, so is its culture which is fundamentally defined as the meeting point of three regions: Central Europe, Eastern Europe and the Balkans. Slavic people, who migrated and settled in neighbouring Serbia, Bulgaria and Ukraine, brought major influences to the culture during the Middle Ages. The most recent influences to Romania's diverse culture have been influenced in particular by French and German culture.

Figure 1. *Map of Romania.*

The diversity and beauty of this country's mountain scenery and wildlife has not been neglected with Romania proudly containing thirteen national parks. The centre of Romania is dominated by the Carpathian Mountains with fourteen of its mountain ranges exceeding altitudes of 2,000 m. This mountain range hosts glacial lakes, fantastic scenery, impressive gorges and, of course, many caves. Spread amongst these mountain ranges are numerous limestone regions which are host to countless cave systems. The country is split into five biospelelogical provinces, each host many cave systems; Oriental Carpathians, Meridonals, Banat Mountains, Apuseni Mountains and Dodrogea. Of these five provinces, the

most important limestone areas for caves are situated in the Apuseni Mountains and to the west of the Meridonali Carpathians.

Whilst Romania was under Austro-Hungarian rule, the first biospeleological research was conducted by Austrian and Hungarian zoologists in the centre and west of the country in Transylvania and the Banat. In 1920, Romanian caving interests flourished with the opening of the Speleological Institute in Cluj. Since then Romanian cave research and speleological activities have developed and grown and in May 1994 the Romanian Speleological Foundation was founded with the aim to encourage and strengthen national subterranean activities.

Despite the study into the subterranean really taking off in the early 1920s, research in Romania was severely under funded during the rule of Ceausescu in the late 1980s. As a result many of the talented young researchers left the county to work for institutes with better funding, leaving Romania with a so called 'brain drain'. Now that Romania is part of the EU, the funding is to increase to fit in with the EU's goal of 3% of the GDP being spent on research, although the target set within the country is currently 1% by 2010.

CAVING AREAS IN ROMANIA

Within Romania there are more than 10,000 caves, spread throughout the country. However, a majority of them are located in the west and south-west of the country. The major caving regions are bordered by the Apuseni and Carpathian Mountains to the east, the River Danube to the south and the borders with Serbia and Hungary to the west and north respectively. This is due to the prevalence of limestone rocks in these regions.

The largest limestone area in the Carpathians is the Padurea Craiului Mountains. Located in the North West corner of the Carpathians, it is a relatively low lying and wooded area, with a high density of major caves (greater than 1 km in length). The area is home to Pestera Vintului which translates as Cave of the Wind, so called because of the strong draught at the entrance. It is the longest cave system in Romania with passages stretching for over 42 km on three levels. There is currently work ongoing to develop it into a show cave. The area is home to Ciuc Ponor and Cornilor Cave which are also large at 17 km and 10 km respectively, along with numerous other large cave systems.

The area which contains the highest number of major caves in Romania is known as the Bihor Mountains. It is located to the west of the Carpathians and is home to ten major caves. The Bihor Mountains are large and spectacular and contain one of the most important karst regions in the country, Padis plateau. They also contain the second and third longest cave systems in the country, Paraul Hodobanei Cave and Dealul Humpleu which are 22 km and 21 km in length respectively. Scarisoare Cave which is also located in the Bihor Mountains houses the largest underground glacier in Romania. The area also contains the country's only current show cave, Pestera Ursilor, or Bear Cave. There was a rockslide 15,000 years ago which blocked the entrance to the cave, trapping 140 bears inside. The remains of the bears show that they were forced to turn to cannibalism in a bid to survive. The cave receives approximately 200,000 visitors per year and is extremely popular with tourists.

Another important caving area in Romania, which is located at the most southerly point of the country's most major caving region, is Clisura Dunarii. It contains numerous caves which can be difficult to access as they are located in steep valleys along the banks of the River Danube. The largest cave system in the area is Pestera Comarnic, which is located on the border between Clisura Dunarii and the Anina Mountains, another major caving area. At 6201 m, it is

one of the largest cave systems in the area and is named after the nearby village of Comarnic. Pestera de la pârâul Ponicova is an entrance to this cave system which opens onto the River Danube. Pârâul is the Romanian word for sink or swallow hole.

As mentioned above, the Anina Mountains is an important caving region that borders Clisura Dunarii. It contains the cave systems, Pestera Comarnic and Buhui Cave which are approximately 6 km and 7 km in length respectively, along with numerous other major caves.

Another major caving area in the Carpathians is Cernei Valley. It is an extremely picturesque, forested valley that lies in the south west of the Carpathians. It contains a few major caves, among them Lazului Cave and Closani Cave which measure approximately 4 km and 1 km. The valley also contains numerous smaller caves.

The Mehedinti Plateau is located further south near to the River Danube and is one of the most important caving areas in Romania. It contains numerous large cave systems, but the one that is widely agreed to be the most impressive is the Topilnita Complex. It is one of the largest cave complexes in Romania at approximately 20 km and is also believed by many to be the most beautiful system in the country with numerous large chambers and spectacular features. It is a very well preserved cave and requires a permit and guide in order to be entered and explored.

Another important area in the region for caves is Retezatul Mic. It is located north of the River Danube and to the west of the Carpathians. It contains four caves greater than 1 km in length and numerous smaller caves. However, it does show genuine potential for further discoveries.

This list of caving areas is by no means exhaustive, but it does represent some of the more important regions. Numerous other areas contain a vast number of smaller cave systems.

Figure 2. *Helictites in Pestera Aven Din Cioaca Cu Brebeni*.

CAVES VISITED

Whilst in Romania our group visited a selection of caves in the south-west of the country, taking in caves from three of the main caving areas. The group was based at the Emil Racovita Institute of Speleology in Closani, located in the Cernei Valley. The caves visited are described below.

The Cernei Valley

"Pestera Aven Din Cioaca Cu Brebeni" (Rocky Hill, Little Flower)

Location: A fifteen minutes walk from the Institute, on the eastern flank of the Lzuorelor valley.

Description: The entrance is gated and padlocked, as it opens straight over a 6m pitch. This descends into a small chamber. From here a larger chamber is entered after stooping though the obvious opening ahead, down some boulders. In the chamber are many tall stalagmites and some examples of 'popcorn' calcite. A passage on the right descends into a small chamber with a ceiling covered in helictites.

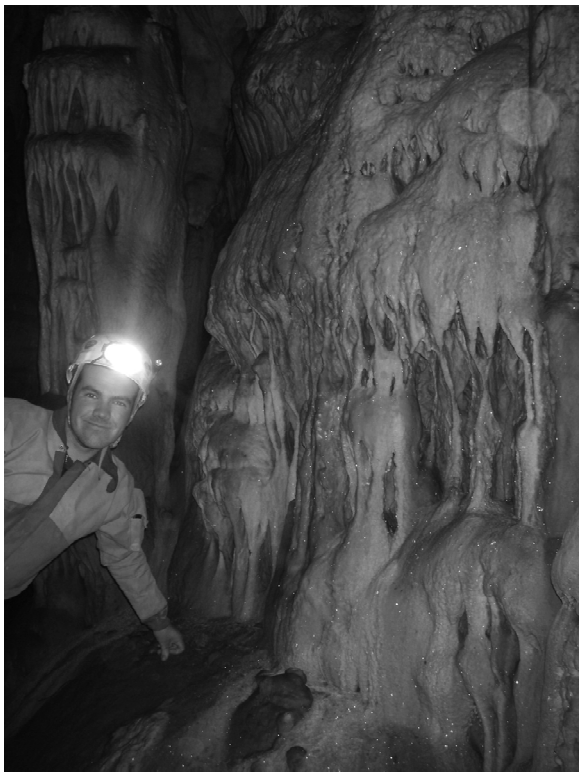

Figure 1. *Formations in Pestera Closani.*

"Pestera Closani"

Location: This cave is a ten minute walk up an obvious footpath from the Closani village. The cave is gated.

Description: The cave is split into two main passages. The lower is reached via a fixed ladder and is used for research. It has concrete paths and concrete labs built for use by the researchers. Despite all this, the passage has many fine examples of speleotherms. The upper passage is the Crystal Gallery. It is full of largely undisturbed crystals, gour pools and speleothems and is reached via a locked door within the cave and a short fixed ladder. Pestera Closani was until recently known as the most beautiful cave in Romania.

"Pestera E.A. Martel"

Location: About 2 km from Closani, located on the northern bank of the Motru Sec valley. The entrance is a small hole at the side of the road.

Description: A tight entrance leads down on to a gravel slope. After a number of small rifts, a 5 m pitch is reached. This is usually a ladder pitch, but a knotted rope will suffice. A sandy passage is found at the bottom, which then leads to an easy traverse. Beyond this is a sump which is passable in dry weather.

"Pestera Lazuli"

Location: The entrance to this cave is a five minutes walk past "Pestera E.A. Martel", on the southern bank of the Motru Sec valley is.

Description: The initial stage of the cave is water and gritty sand covering the floor. Near the entrance is a duck which can sump in poor weather. The cave is quite straight forward, with climbs and squeezes to explore as one walks along the main passage way. There is a series of small holes that, upon exploration, reveal themselves to be interconnected. The walls are covered in a thin layer of mud, which has allowed arrows and names to be drawn on to the walls, revealing the white rock beneath. This makes for easy route finding. A second sump can be found at the end of a relatively long passage.

Figure 4. *The entrance to Pestera Drumului din Cheile Comoristi.*

"*Pestera Drumului din Cheile Comoristi" (Children's Cave)*

Location: Situated 5 km west of Obarsia Closani, towards Baile Herculaine, is the small entrance to this cave. It is found next to the road.

Description: The entrance appears small at first glance but it is easier to fit through than initially expected. The passage is smaller and muddier than most of the other caves encountered on the trip and bears a certain resemblance to caves on Mendip, in south-west England. The passage undulates before reaching the first pitch (approx. 10 m) which leads on to a crawl. This in turn opens up to a more comfortable passage which then ends in an awkward 3 m climb up. The second, longer pitch is then reached, followed by a sump.

Mehedinti Plateau

"Pestera de la Podual Natural" (Cave of the Natural Bridge)

Location: 4 km from Baia d'Arama on the road going south west from Cracu Muntelui is the village of Ponoarele. Once through the village an impressive natural bridge is located, after which this cave is named.
Description: The entrance to the cave is large and continues as a long and easy going passage for quite a way. A chamber is reached, and has been marked with graffiti, one notably pointing out the presence of a W.C in one of the alcoves (best to avoid this one!). There are some pretty features, but this cave is more famous for the bats that roost there. Indeed, at the entrance is a sign informing visitors not to disturb them. A depression marks the location of a dried out lake, which has left the cave floor around that area very muddy. There is a second entrance situated on the far side of the main entrance and over the ridge.

"Pestera Bulba's"

Location: A river follows a section of the road from Baia d'Arama to Podual Natural and Topolnita and then breaks away to the right. Following this for around 500 m takes you to the entrance of this cave.

Description: The cave starts with a 2 m sump, which is only a duck if there has been very little rain. This opens up to a large passage which follows the stream. On the right is an awkward 5 m climb up, which is the way to the round trip. The way on passes through many varied passages, some thigh deep in water, and continues past many pretties including stalagmites, stalactites, curtains and gour pools. A long flat out crawl leads to more passage and then to a muddy boulder chamber, where it is difficult to find the way on. The group failed to find this way on to complete the round trip and so returned out the way they had come.

"Topolnita"

Topolnita is the third largest cave in Romania, at 20,500 m, and contains passages on four levels. The group explored two of the entrances during their stay.

Location: The cave is located near the village of Jupanesti.

Description: "Pestera Femeii" entrance is located halfway down a narrow path leading down the side of a cliff. The entrance is gated, as this cave is protected and cavers require permits in order to enter. They must also be accompanied by a guide. There are some bat grills here as the cave is home to around 3000 bats. The small entrance passage soon opens up into a large cavern. Across a metal bridge above a very deep void, there are large numbers of formations. These include thin columns several metres high, beautiful curtains and the spectacular Crystal Lake. A study is currently being conducted as the land owner recently changed the flora located on top of the cave to pine trees. This has changed the acidity of the water filtering though and is corroding some of the rocks in the cave.

Figure 5. *The Crystal Lake in Topolnita.*

Description: The second trip the group undertook in the Topolnita system began at the bottom of the cliff. The entrance to this part of the cave is very large and many boulders have to be negotiated before the cave is reached. Inside, the passage is very tall but only a few metres wide. The cave follows a river which can become very deep in places. Some sections are swum and some waded. A through trip can be made to another of the cave's entrances.

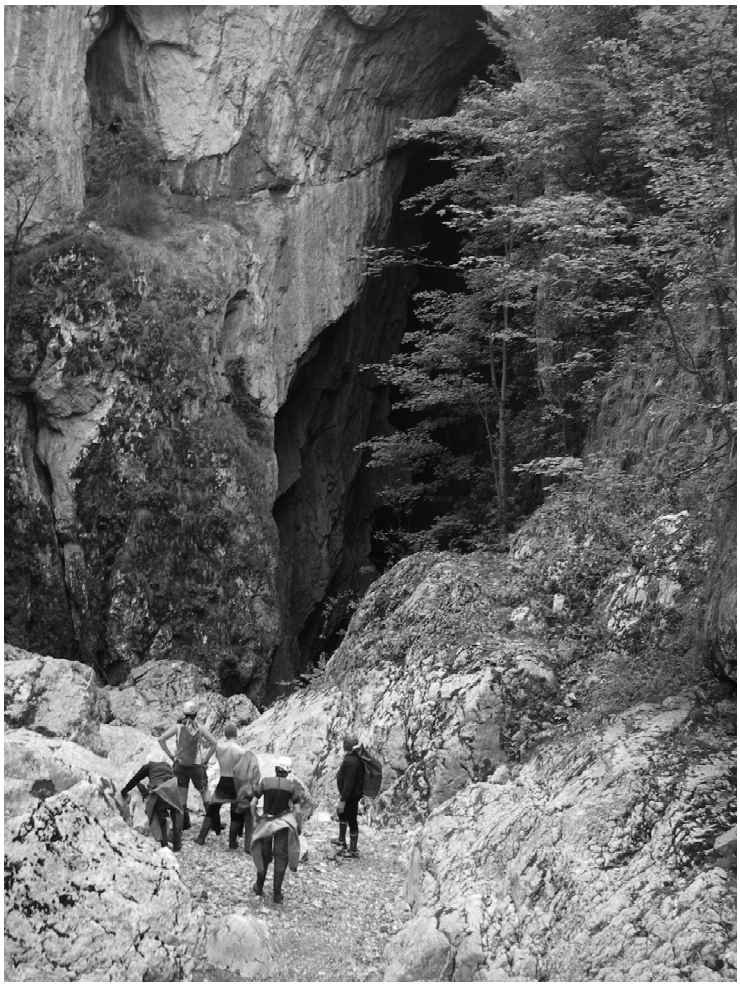

Figure 6. *The second entrance visited in the Topolnita cave system*.

"Pestera Curecea" (4565 m)

Location: The cave is near the village of Balta, located around 25 km south west of Baia d'Arama. The entrance is at the bottom of a big pit in the hills, and is accessed via a climb down loose rocks.

Description: Once inside the cave, a left turn leads through a reasonable size, round passage with boulders in the bottom of it. There are ample fossils embedded in the rocks. The passage emerges at another entrance but the party returned the way they had come, exploring side passages on the way back. One of these, at the top of a small climb, contains some pretty formations and then loops back into the main passage. Back at the entrance, taking the right

turn instead is a sandy and rocky passage, of similar shape to the first one. This passage is active and can sump.

Clisura Dunarii

"*Pestera Ponicova" (1666 m)*

Location: The cave is in the Danube gorge, near the village of Cazane.

Description: The entrance is a large vertical slot, where a rickety ladder has been placed to assist the awkward climb down. Down the ladder and to the left is a climb up to a passage, which contains a few stalagmites and stalactites. Straight ahead, the passage eventually reaches water. This is an inlet from the river Danube, to which the cave opens. The water is safe to swim in, although care should be taken not to swim too far out due to the strong currents in the river One need also be wary of vipers.

KARST RESEARCH

As a country with many important karst regions and caves, Romania is active in karst research. This research is primarily based in government funded institutions, the foremost of which is the Emil Racovita Spelaeological Institute; there are also several smaller organisations which either perform their own research or assist others.

The oldest of the organisations is the Geological Institute of Romania (GIR). Its original and primary task is not in karst research but in geological mapping. An earlier organisation, the Geological Bureau, was founded in 1882 and from this the GIR was established in 1906. The Institute later diversified from producing accurate geological maps and developing techniques in agrogeology, geophysics, geochemistry and engineering geology.

The focus of the GIR used to be on exploration, mining and construction. As industries chang, mining has become less important and social and environmental issues have come more to the fore. The GIR is a valuable resource which has been able to support research and work by other organisations owing to its knowledge of Romania's structure and its minerals.

In 1920 the biologist Emil Racovita founded the Romanian Speleological Institute, which has borne his name since 1958. This was the first spelaeological institute in the world. The first staff were Racovita, Rene Jeanel, a French entomologist, and PA Chappuis, a Swiss subterranean aquatic crustacea specialist.

The first of two major reorganisations happened in the 1950s beginning with the establishment of a second centre in Bucharest (the first being in Cluj) in 1956 and in emphasis on biospelaeology, physical spelaeology and spelaeopalentology. The second was in 1990 when the Romanian Academy split the institute into its five current departments: biospelaeology, phreatobiology, spelaeopalentology, geospelaeology and regional karstology and karst survey.

The geospelaeology and regional karstology and karst survey departments focus on the karst itself. They seek to increase the knowledge of the systems and dynamics of the karst and its structure and hydrology. In particular at the moment the former department aims to place the Carparthian and Pontic karsts within the evolution of Europe and the latter to produce an

understanding of the individual nature of Romania's karst in order to produce an Atlas of Romanian Karst.

The institute current employs 35 researchers and co-operates with many non-governmental organisations (NGOs) and universities and institutions around the work. Since 1983 it has organised an annual international Symposium on Theoretical and Applied Karstology.

The Romanian Spelaeological Federation (RSF) and Romanian Spelaeology Karstology Society (SRSC) are organisations which assist in the research and conservation of the caves in addition to promoting caving and educating people about karstology. The RSF was founded in 1994 from the amalgamation of several other societies: the Central Commission of Spelaeology, the Romanian Society of Spelaeology and Karstology, the Transylvanian Spelaeology Society, the Spelaeological Society of Banat and the Group for Underwater and Cave Exploration. It is a voluntary and sporting organisation. It is affiliated with the International Union of Spelaeology and has contacts with similar French, Hungarian and Italian organisations and is looking to develop more. The SRSC is an NGO set up in 1990 and its members comprise of individual members, caving clubs and environmental groups. It operates under the coordination of the Romanian Academy and the Spelaeology Institute Emil Racovita.

Although these institutions are individual, despite their interaction, they are mainly government funded and affiliated to government organisations. Ultimately this means that the research into karst is centrally controlled.

For the fifteen years before the fall of communism in 1989, Romania had one of the most totalitarian regimes in Eastern Europe under the rule of Nicolae Ceausescu. During this era most of the regimes in the Eastern block were still pouring resources into research, but in Romania, Elena Ceausescu, the wife of Nicolae, dominated the nation's science policy and decimated the Romanian academy and science was falsely hailed as a social priority. During this period ideological interference reached incredible heights, but funding was more consistent than it was during the 1990's and the early years of this decade. After the execution of the Ceausescus in 1989, Romania was in the process of being rebuilt and research funding declined further; by 1997 it was below 0.3% of gross domestic product compared (GDP) to 2.5% in leading industrial nations. During this period many of the nation's researchers left and went to work abroad where funding was better and they could buy equipment which could not be afforded in Romania. A survey in 2000 showed that 66% of Romanian students are likely to emigrate, amongst these many of the top graduates, leading to a national 'brain drain' as their relative income and the social prestige of science diminish within Romania.

Now that Romania has become a member of the E.U. their research funding must increase as the E.U. aims for 3% of GDP to be spent on research. The Romanian government target expenditure is 1% GDP by 2010 and they aim to increase the participation of Romanian researchers in international programs such as European Research Area and FP7 thus gaining access to E.U. funding. The Funding increased from 0.22% of GDP in 2003 to 0.38% in 2006 meeting the targets set for both 2005 and 2006. FP7 has 4 categories of objectives: Cooperation, Ideas, People, Capacities and bundles together all research related E.U. initiatives. The research carried out in caves throughout Romania and by those working at the institute contributes to the environment theme which is proposed under FP7. This particular theme has € 1.8 billion earmarked for funding during the period 2006-2013. Romania was also an active participant in FP6, the program aimed at harmonising cooperation within the European Research Area.

In addition to the government, the private sector and the higher education sector also contribute to research funding. These sources both declined during the last decade. The private

sector funding was 0.62% of GDP in 1995 decreasing to 0.21% in 2004, whilst the higher education sector only accounted for 0.02-0.04% of GDP for this whole period. The national university research council now funds high quality research and post graduate training in universities, but this only receives 5% of the research and development expenditure within the country. Both private sector and higher education funding have now begun to increase and private sector funding was up to 0.42% in 2006.

Since the fall of communism the number of scientific papers published in international journals by Romanian researchers has increased 190% with the majority being in the fields of chemistry, physics, engineering and mathematics. However in this period the number of papers in engineering, medicine and social science have decreased whilst those in biology, earth and space sciences and physics have increased.

Although most countries put more funding into engineering and technology, this is exaggerated, with 77% of funding going to these fields at the expense of other subjects and the majority of research in Romania is still applied research carried out by the enterprise sector.

The situation is now looking better as the funding both from within Romania and from the wider scientific community increases and new equipment can be afforded. However the research community was heavily depleted during the immediate post communist era and until the number of experienced researchers increases, either by return of ex-patriots or qualification of new graduates there is a limited amount that can be done. The salaries of the researchers are still very low in comparison to the average wage, but they have been increased in recent years.

CURRENT RESEARCH TOPICS

There is currently a huge amount of different research projects underway at the Institute of Spelæology in Closani; they have been very active in recent years and produced a wealth of material. This part of the report focuses on the current research interests, discoveries and failures.

In Closani cave there are some fantastic examples of crystals. Marius Iser one of the researchers, who also acts as one of the guides is currently trying to better understand their growth. He is looking at their initial formation patterns to try to better understand how they form.

Virgil Daragusin, the second of the researchers who also acted as our guide, is aiming to retrace the water levels of the Black Sea through the quaternary period, using the growth of patterns of stalagmites as a proxy.

The proxy works by using cave samples that are close to the water level of the Black Sea. Thus when the Black Sea is at a low level, then periods of stalagmite deposition occur, the water levels in the cave should be at a similar low level. When water levels of the black sea are high, the cave is assumed to be flooded and no stalagmite deposition occurs. Stalagmite growth periods are calculated using Uranium dating methods, through mass and alpha spectrometry, with the other variables which effect the U:T ratio other than time taken in to consideration, these are being the presence of Guano or the presence of fresh water.

Once the periods of growth of the stalagmites have been determined and ages of these growth periods have been dated, the water levels in the cave and thus the levels and extent of the Black Sea can be determined. This is currently producing some very interesting results, which it would be wrong to publish here, as the research is not yet in the public domain.

As well as the use of stalagmites as a proxy for the Black Sea, they are also being used as a proxy for world climate patterns. This is achieved firstly by looking at the ratio of

Oxygen-18 (O^{18}):Oxygen-16 (O^{16}) isotopes to calculate the temperature and the extent of ice coverage on the planet. To strengthen the evidence produced by the O^{18}:O^{16} the Carbon-13 (C^{13}): Carbon-12 (C^{12}) is measured. If there is a high C^{13}:C^{12} ratio, then it follows that there are more C3 organisms than C4 organisms in the region during the period of deposition, due to the photosynthetic routes that each take. C3 organisms thrive in higher carbon dioxide (CO_2) environments, so if there are a greater number of C3 organisms then the CO_2 concentrations are also higher. This implies that the global climate is warmer due to an increased greenhouse effect. Using these proxies it is further hoped that they will support the evidence for past global climate variation as presented in the Vostok ice core -Antarctica, the NGRIP ice core -Greenland and the foraminifera record in oceanic sediments.

Other research that has been inconclusive in Closani cave included a very complicated set up for recording the change in cave atmosphere and conditions. It consisted of a highly sensitive set of thermosensors, moisture sensors and data loggers rigged in many places around the cave. However it became apparent that the 'irreplaceable cable' had been lost, and there was no way of accessing/analysing the data. The project was abandoned.

Another experiment had an array of lasers and light sensors mounted on multiple levelled metal platforms with their heights accurately measured. Earth movement was to be recorded by changes in the level of the lasers on the sensors. Although the data was collected over a long period of time, and produced many results, there was too much noise in the data for it to be useful or conclusive. The source of the noise was the fact that at the time of the experiment a large hydroelectric dam was being constructed. Consequently there was a large volume of heavy plant machinery on the road above.

The recording of stalagmite growth, calcite deposition and the time period with respect to the water falling on the feature, has also been attempted This was tried by placing a small glass plate on top of a stalagmite for a known time and with a known drip rate. The growth over a period of months was then to be recorded. However other cavers taking out the glass sheets continually disturbed the experiment. This was because cavers assumed that it was litter that they were removing, or they would dislodge them and not replace them. String has now been used instead of the glass sheets and data is now being produced, as people are not interfering with it.

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