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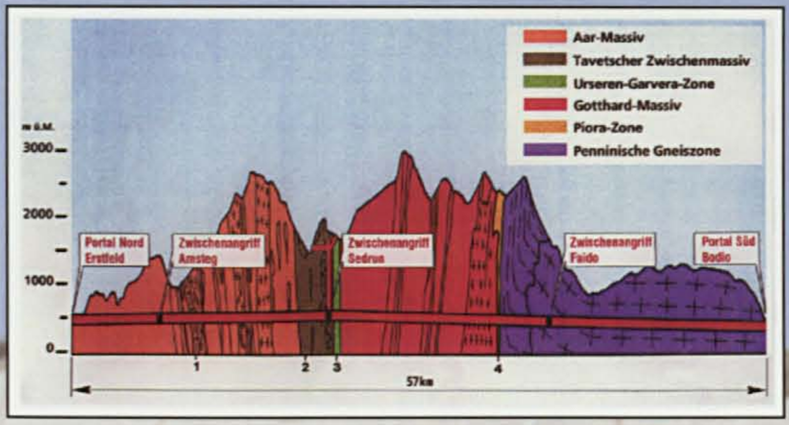

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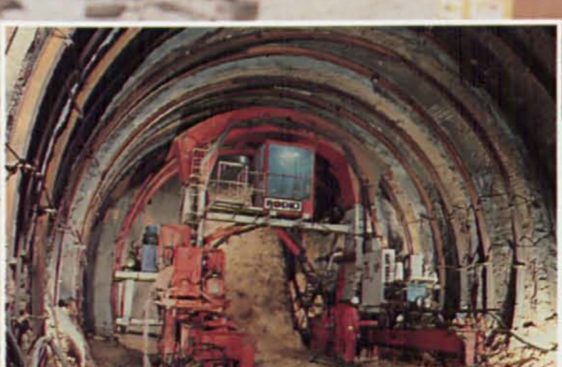

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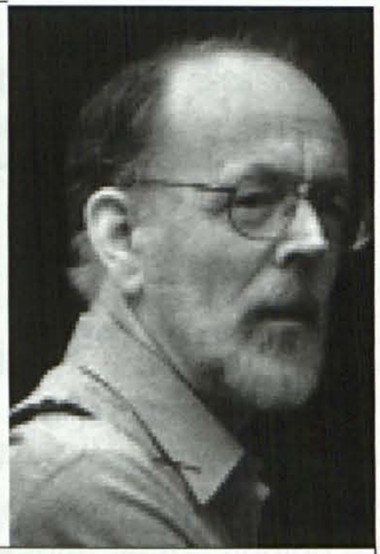

HAPPY 20TH BIRTHDAY EFG!!

It is 20 years since the Federation was formed in July 1980 by six national associations. From this small beginning we have grown to represent 20 countries from across Europe and now speak for 75,000 geologists. We also have a reciprocal Associate Membership with America, several European observers and contacts across the world.

Amongst the initial objectives was «to represent the geological profession in Europe». In the last few years we have made presentations to the Director generates of the European Commission and to the European Parliament. Most importantly we have learnt how to be effective in our contacts, as shown by our current involvement with the new Sludge Directive. It has also been clear for some time that we need a presence in Brussels to be close to the heart of European activity and the Board is actively looking at this.

We are championing the right of geologists to move around Europe. So far we have been able to sort out problems for geologists in several countries through our local contacts. However we have not yet been able to persuade the EU to address the necessity for geologists to practice and sign reports freely throughout the Union. We are actively pursuing this point.

The adoption of the Code of Ethics or Deontology gave us a firm base of quality on which to form the requirements for the professional title of European Geologist. There are now over 200 geologists who have been approved and who have received the EurGeol. title with its identity card and pin. The rapid development of professional geology and the commitment to Continuing Professional Development are some of the threads which have drawn us, with our global colleagues, to convene the first International Geological Conference in Alicante this July.

The Founding Fathers were also concerned with European policies concerning natural resources, land development and environmental issues. We still have some way to go before we can see a Geologists Bill go through the European Parliament, or be able to influence policies on natural resources and land planning. However one of our working groups, on environmental matters, has been prominent in producing on-going dossiers and influencing draft Directives.

Our ability to communicate with our national associations and European geologists relies heavily on this fine magazine, the regular Eurogeopages newsletter and most recently on our developing website at «efg.gsf.fi». I particularly thank our colleagues who work so hard to make them possible.

The viability of the Federation depends on the enthusiasm of all our delegates and their commitment to the ideals of the Founding Fathers. We are presently sadly underfunded, so following our recent programme of re-organisation and financial rectitude, we are now moving on to address this problem. This combination of commitment with financial backing will allow the further development of the Federation as we look forward to the next 20 years and more.

EurGeol. Gareth Ll. Jones
President

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The enigma of low prices in times of pending oil shortage
El enigma de los bajos precios del petróleo cuando esta pendiente un período de escasez
L'enigme de la deprime des cours du pétrole en période de production chronique insuffisante

C. J. Campbell

Abstract

We are now in times of oil shortage, but the prices per barrel are descending instead of going up. The reason could be the new oil reservoirs found. This makes us think about two questions: How much has been found? When was it found?

The database reservoirs from the different companies differs from one to another, because some of them, as BP includes in the database new reservoirs that were already found but weren't published at the time they were found. This article talks about some companies, and how their reservoir database changes in terms of the financial position.

Resumen

Nos enfrentamos a un período de escasez de petróleo, pero los precios del barril en lugar de subir, bajan. La explicación puede ser el hallazgo de nuevas reservas de petróleo. Esto nos lleva a preguntarnos: ¿cuánto se ha encontrado? ¿Cuándo se ha encontrado?

Los datos de cantidad de reservas proporcionados por diferentes empresas del sector en el mismo período, difieren unas de otras. Esto se debe a que algunas empresas como BP, hacen referencia al hallazgo de reservas que apuntan como nuevas, cuando éstas ya existían pero no aparecían reflejadas en ninguna base de datos.

En este artículo se hace un recorrido por algunas de ellas y como sus datos de reservas ofrecidos, cambian en términos de su posición financiera.

Résumé

Actuellement, nous sommes dans une période de pénurie de pétrole et pourtant les prix du baril diminuent au lieu de monter. De nouvelles et récentes découvertes de gisement pourraient expliquer ce phénomène. Cela nous conduit à réfléchir à d'autres raisons, celles qui régissent le nombre annoncé de gisements en réserve. Les données sur les réservoirs, fournies par les différentes compagnies sont variables d'une compagnie à l'autre parce que certaines, comme BP, entrent dans leur base de données de nouveaux réservoirs qui sont déjà connus mais dont l'existence n'a pas été divulguée au moment de leur découverte. Cet article met en scène quelques compagnies et traite de la façon dont leur database évolue en fonction de critères purement économiques.

Before you can produce oil, you have to find it. That I suggest is where the explorer comes in. In earlier years, finding oil was a hit and miss affair as they drilled structures close to seepages. But exploration is now a highly technical scientific process.

Advances in geochemistry define where the out source rocks are and when they gave up their oil.

Oil generation advances in seismic surveys means we now have the resolution to see the smallest trap with unparalleled clarity.

Seismic section advances in geology means we understand better all the processes that led to the formation and entrapment of oil. Furthermore we understand better the statistical distribution of oilfield size.

I suggest that we are now better able to assess the world's endowment of oil than previously. I disagree with those who say that bad forecasts in the past condemn all forecasts.

I submit therefore that it is time to ask two questions: how much has been found? and when was it found?.

You would think that these are questions for the explorer and the engineer, but in reality we need the accountant and the detective because the reporting of reserves both by companies and governments, has been so unreliable. Sherlock Holmes I will therefore give up the geologist's hammer and pretend instead to be a Sherlock Holmes.

Before you can produce oil, you have to find it. That I suggest is where the explorer comes in. In earlier years, finding oil was a hit and miss affair as they drilled structures close to seepages. But exploration is now a highly technical scientific process.

I will start by looking at the reserve data published by BP, a knowledgeable and respected oil company, who puts out a booklet called «The Statistical Review of World Energy».

BP Statistical Review lists what it describes as Proved Reserves. My first question is: What is meant by that term?. Does it mean the best estimate of the amount of oil in a field? Or does it mean the lowest estimated of what is there?. One way to answer that is to look at the evolution of reserves over time. If they are the best estimates, then any revisions should be statistically neutral, with as many down as up. If they increase over time, it means that the estimates started low.

Let us look at the reserves reported over time by the main producing countries.

Middle East Reserves 1980-1996 since there are many representatives from these countries here, I will choose my words with extreme care to avoid giving offence. I am the detective, not the judge.

First we have an 11 Gb increase reported by Iraq in 1983. But as I searched through the sand dunes with my binocu-

lars I could find no evidence of such discovery that year. Later, my investigations revealed that it was the late reporting of a field found in 1976.
I realised that reserves are not necessarily reported when they where made.
Then in 1985, Kuwait announced a 50% increase, implying that something new (the size of, say the UK North Sea) had been found. I could not find no evidence for it.
I did discover that the increase greatly upset: Kuwait's neighbour Iraq. I also discovered that OPEP quota was partly based on reserves. A detective looks for motives in reserve reporting.
Then in 1987, Venezuela doubled its reserves by admitting large amounts of heavy oil that had been known for years. I could find no evidence that there had been any particular technological justification that year for this huge increase.
I then noted that Abu Dhabi, Dubai, Iran, Iraq retaliated with enormous overnight increases, followed two years later by Saudi Arabia.
I was also struck by the circumstantial evidence of the Neutral Zone. It is controlled by Kuwait and Saudi Arabia and announced no increase.
I wondered if its owners had no common motive to report an increase.
Lastly, I noted that the numbers have barely changed since this sudden large increase despite substantial production.
I questioned the plausibility that new discovery should have exactly matched this production to leave the reserves unchanged.
This evidence led me to reject this data set as unreliable evidence. That in turn led me to reject the many reports based on this data set that spoke of global reserve growth and replacement.
BP Reserve growth I accordingly turned to Petroconsultants who maintain the world's largest database on individual fields and wildcat drilling.
And I put my junior detectives to search out explorers and engineers who knew the fields in these countries. It was not easy. I heard for example from an ex Aranco engineer. Bit by bit, the story was pieced together.
I discovered that the numbers before the increase of the late 1980s were too low. The reason is that they had been inherited from the oil companies before they were expropriated. Oil companies treat their reserves as inventory to be drawn down as suits their financial position.
But the important point is that the revisions have to be backdated to the fields containing them, which had been found up to 50 years before, since nothing had been added. It makes a huge difference to the discovery trend.
Eventually the investigation covered the whole world. I was able to answer the two questions I had asked.
About 1615 Gb had been found and discovery peaked in the mid-1960s. Genuine discovery trend.
The United States Geological Survey was making a parallel investigation. It now reports a total discovery of 1608 Gb. A number very close to mine.
In doing all this, I had to define what I was talking about. I found that more than 95% of all oil produced to-date came from what is conventional oil under definition. I further found that 90% of to-day's production came from fields more than 20 years old and 70% from fields more than 30 years old.
These are pretty well known fields with fairly accurate data.
The next part of the investigation led me to ask:
- How much is left to find?
- How fast is it being found?
- How much to find and how fast

Again I confined my attention to conventional oil.
I discovered that experts had developed statistical techniques which could help answer these questions.
There isn't any time to discuss them here but I will briefly illustrate them.
- Statistical techniques
- The hyperbolic creaming curve
- The parabolic fractal
- The correlation of discovery and production peaks

To simplify let us just extrapolate this discovery curve. Midpoint was in the 1960s and it is easy to extrapolate it to an ultimate of about 1800 Gb.
Note the falling rate of discovery despite the advances in technology. There was evidently less left to find.

Repeat discovery trend

I also plotted the find rate, which has been falling for many years and is now down to about 6 Gb/a.

Discovery production gap

It means that we produce four barrels for every one we find.
I checked again with my rival detective agency, the USGS. They had a broader definition of what they term conventional oil. In 1994, they showed an ultimate of 2300 Gb, but that has now reduced to 2078 Gb.
The two numbers are close enough.
Parameters.
To sum up, these are the essential statistics:

– Produced	792 Gb
– Reserves	823
– Discovered	1615
– Yet-to-find	185
– Yet-to-produce	1008
– Ultimate	1800
– Production Rate	23 Gb/a
– Discovery Rate	6 Gb /a
– Depletion Rate	2.2% /a

Note that under my definition, deepwater and polar oil are treated as non-conventional and excluded from these statistics.
The next part of the task was to model depletion.
It did not take long to realise that production in any country begins at zero and ends at zero when it was exhausted.

Zero-peak-zero

As I said earlier: before you can produce oil you have to find it.
It soon became obvious that one or more peaks of discovery would be followed by one or more peaks of production after a given time lag.
Looking into the discovery record of many countries, it became evident that once a successful geological trend was identified, the larger filches came in first, being too large and there were virtually no economic or political constraints as both of the companies and the governments wanted to have the revenue as fast as possible.
It soon became evident that the overall peak of production more or less, coincides with the midpoint of depletion.

US depletion Midpoint

This then gave a basis to model production in every country.
In global terms, the simplest model shows that peak will come when half the Ultimate , namely 900 Gb, have been produced. On present trends that will be around 2001.
World midpoint but that ignores the uneven distribution of oil. About half the yet-to-produce occurs in just five Middle East countries. Not only do they have large reserves but they are depleting them at a very low depletion rate. In resource terms, it gives them the ability to act as swing producers around mid-point

making up the difference between world demand under various scenarios and what the other countries can produce. Whether they exercise their swing role is for them to decide.

Scenarios. One can imagine any number of scenarios. This slide shows three, but I will be content to describe the Base Case.

It assumes that world demand increases at 2% a year until the swing share exceeds 30%. That is taken to be the threshold when control of the market by the swing countries gives rise to a substantial price increase. The other countries have no response, because they are already producing at the maximum rate their resource base allows.

This price shock is assumed to curb further demand increases and lead to a plateau of production, until swing share reaches 50%. By then, these countries will be close to their depletion midpoint too. After that, production will have to decline because of the immutable physics of the reservoir.

So, I picture a two phased crisis. The first is a price shock around 2000. The second is the onset of physical shortage about ten years later.

Two-phased crisis. My colleagues and I have been arguing this case for some years - more or less as voices in the wilderness. We have been derided by the flat-earth economists who say that oil reserves can't be measured and that depletion is meaningless because production is just a matter of price and technology.

They even went so far as to tell us that oil is of inorganic origin, such that beneath every oilfield is another awaiting discovery fed by a vent from the interior of the earth. It does not say much about their technical grasp of the subject.

Flat Earth economist's view

The IEA asked us to confront these people at a meeting last November. I am glad to say that the IEA has now delivered its verdict. It unequivocally accepts our model. It has a non-swing peak in 2000, a global peak in 2013 and a shortfall of 17 Mb/d by 2020.

IEA new position

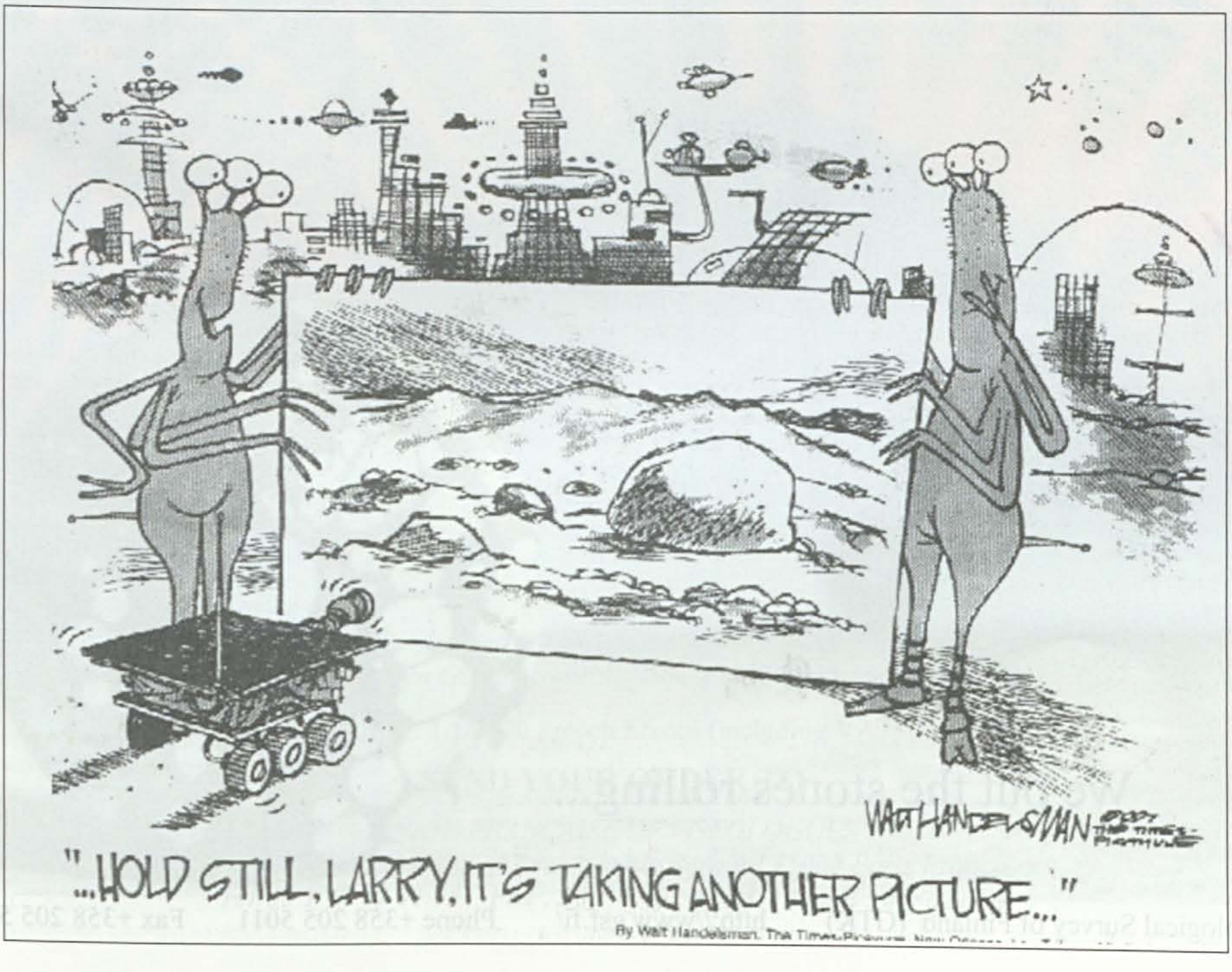
It built its model on the USGE ultimate of 2300, rather than our 1800, but the USGS number now has revised downwards to about 2000. So the EIA peaks would now come a little sooner.

I also note that the CEO of Agip, recently published his belief that world peak would be between 2000 and 2005.

Agip Statement it seems to me that we are no longer voices in the wilderness, but rather express the Establishment view, given that the G8 ministers accepted the IEA report.

Anomalous low price. I therefore have no hesitation in describing the present low prices as anomalous, reflecting the temporary breakdown of the control of supply around peak. It would never have happened had the major companies retained their hegemony. It is a consequence of a highly efficient transparent market faithfully reflecting very short term imbalances.

This low price is no more surprising than will be the high prices that are around the comer given any plausible



By Walt Handelsman. The Times-Picayune, New Orleans assessment of the resource base. I think it is a very dangerous anomaly especially to the Middle East producing countries who rely on oil for national revenue.

Protocol I would like to propose a solution

I discovered that several OECD countries signed a Treaty in 1976 which amongst other things established the IEA. This organisation was supposed to study the issue, manage strategic stocks, co-ordinate reactions to an oil crisis and cooperate and co-ordinate their reaction.

I think it would be a simple matter to add a protocol to this existing treat with the following main conditions:

1.–no country would produce at above its current depletion rate.

2.–no country would import any production that exceeded such a rate

3.–all countries would open their reserve data to objective international audit.

4.–There would be several important exemptions for:

Gas and gas liquids

Non-conventional oil including deepwater and polar oil

Countries with small production

Production from new producing countries.

The Middle East would bear the brunt of the reduction but since their depletion rates are very low, the would have to cut back a small percent. They would be reassured to know that no other country would exploit their contribution since all would be bound by the same requirements. It means that their resources will last longer and in the long term will earn much higher revenues from them.

The obligations would be policed by importer and exporter alike.

The world needs exploration and development to continue on the exempted categories, which would not in any case come on fast enough to have any material impact until well past peak.

I think it would lead to an orderly increase in price to everyone's advantage. It would also give the world a chance to learn about depletion and delay for at least a few years the onset of the inevitable growing chronic shortage which arrives at the end of the first decade of the next century.

I earnestly commend this proposal. You cannot allow the operations of an uncontrolled short term market to adversely affect your future so badly.

I stress that past crisis of both high and low prices are fundamentally different from the one we are about to face. The past crisis occurred when the world still had plenty of oil to find and produce. The shocks of the 1970s occurred long before the midpoint of depletion. Now the midpoint peak is very close. It is an entirely new situation. Past understandings, experience and economic reasoning hardly apply to solving an historic discontinuity.

Industrial minerals in the South Cone
Los minerales industriales en el Cono Sur
Minerais industriels dans le Cone Sud

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Abstract

In Argentina and Chile, the industrial minerals are still relegated to a second order due to the brightness of the activities of the metallic mining despite that in the last years in both countries the sector of the industrial minerals is undergoing a vigorous period. The reasons are different for each country, as well as the degree.
The official forecasts point out that before the millennium ends up, the Argentinan mining industry will become the fifth industrial sector of the country whereas 8 years before it didn't figure among the top twenty. How much will it correspond to the industrial minerals?. On the other hand, their Chilean neighbors during the period 1995-2000 will see invest in the non-metallic mining US$1.360M, according to analysts of COCHILCO, what supposes 10% of the total investment of the Chilean mining regarding 1997.
In summary, the conditions that have generated this excellent period of investments are described as well as the factors will work up the industrial minerals of the South Cone.

Resumen

A pesar que los minerales industriales se relegan siempre a un segundo orden debido a la brillantez de las actividades de la minería metálica, en los últimos años tanto en Argentina como en Chile se está experimentado un periodo de bonanza en el sector. Los motivos que han proporcionado este buen momento son diferentes para cada país, así como el grado de augue.
Según estimaciones oficiales antes que acabe el milenio, la minería en la Argentina se habrá eregido en el quinto sector industrial del país; 8 años antes no figuraba en el ranking de los 20 primeros ¿Cuánto corresponderá a los minerales industriales?. Por otro lado sus vecinos chilenos entre el periodo 1995-2000 verán invertir en la minería metálica US$1.360M, según analistas de COCHILCO, lo que supone el 10% de la inversión total de la minería chilena respecto a 1997.
De manera resumida se describen las circustancias que han influido en la generación de este excelente periodo de inversiones y los principales factores que afectarán en el desarrollo futuro de los minerales industriales en el Cono Sur.

Résumé

Bien que les minéraux industriels sont encore relégués à un deuxième ordre dû à la puissance des activités de la minière métallique, pendant ces années dernières dans l'Argentine et Chili le secteur est en train de subir une très bonne période. Les raisons sont différentes pour chaque pays, ainsi que le degré.
Les prévisions officielles annoncent qu'avant le fin du millénaire, l'industrie minière Argentine deviendra le cinquième secteur industriel du pays alors que 8 années avant qu'il n'ait pas été parmi le vingt premiers. Combien il correspondra aux minéraux industriels?. De l'autre côté, leurs voisins Chiliens pendant la période 1995-2000 verront investir dans les minéraux industriels US$1.360M, selon les analystes de COCHILCO, ce qui suppose 10% de l'investissement total de la minière Chilienne par rapport à 1997.
On décrit les conditions qui ont produit cette période excellente d'investissements et les facteurs principaux qui joueront á faveur les minéraux industriels du Cône du Sud.

Thanks to the Mining Investment Law No. 24,196

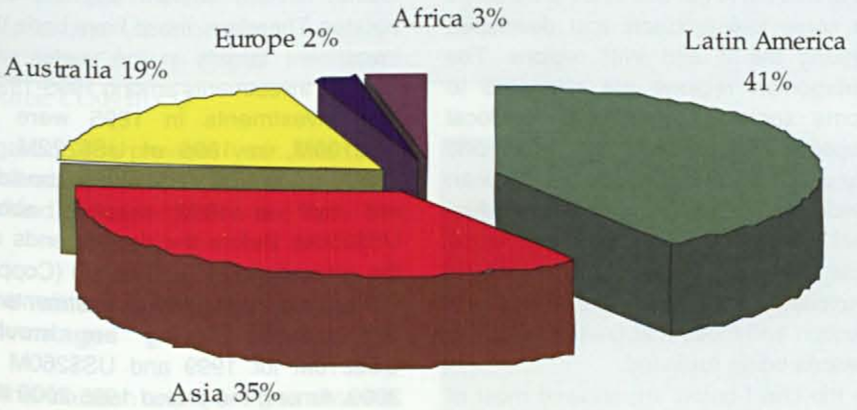
In 1989 Argentina was located in the 5th place among the countries with a more favorable geologic potential and it was considered by the ranking of investment of the main mining companies of the world in the position nº41. With the Mining Investment Law No. 24,196 in 1993 the peak of the Argentinean mining began.

In 1989 Argentina was located in the 5th place among the countries with a more favorable geologic potential and it was considered by the ranking of investment of the main mining companies of the world in the position nº41. With the Mining Investment Law No. 24,196 in 1993 the peak of the Argentinean mining began.

The great geologic potential of Argentina (the 75% of the mining wealth is still unexplored), the guaranteed tax and tax rate stability for 30 years, differentiated tax treatment, exemptiom from assets tax, no import duties, 3% maximum royalties, unification of mining procedural rules, updating the mining register, the environmental protection law and the strengthening of the Mining Regional Bureaux across the Assistance to the Argentine Mining Sector Project (PASMA) give an appropriate scenario for the development of mining activities. To these characteristics is necessary to add the recent Treaty of Mining Integration with Chile and the current environmental restrictions in other countries.
All these factors have given place in Argentina to a growing tendency of the investment in mining exploration; phenomenon that includes all Latin America. MERCOSUR with Bolivia and Chile embraces 43,5% of the total investment

WORLD MINING INVESTMENT FORECAST

1997-2002



Source: Metals Economics Group.

in exploration in the region. The 12% of the world investment in mining exploration in 1991 was made in Latin America, while in 1996 the 27% was dedicated.

The future forecasts of the mining total investment in the world for the period 1997/2002 will be in the order of US$38.200M; estimating that 41% will be in Latin America and 10% in Argentina.

In 1997 with the start-up of Bajo La Alumbrera and Salar del Hombre Muerto, the mining production value in Argentina was of US$715M, 78% plus with regard to 1990.

The mining GDP grew 32% in regarding the previous year, recovery that began in 1992 with a annual average rate of 6,9% that means the double of the economy (3,5%). In 1998 the mining investment will have reached the order of the US$350M, quite bigger that the annual average period 1990-1997.

Several observations can be made to this official chart. In general, just to say that in some cases has been elaborated with the most favorable scenarios.

According to these estimations, the value of the mining production will reach in the 2002, US $2.752M, an increment of 285% with regard to 1997. The total invested in the mining sector among 1996-2002 will add US$4000M, mainly transnational private capital. The exports will reach in the year 2000 US$1309M and the imports US$314M with a favorable balance of US$994M.

The peak doesn't still arrive to the industrial minerals. At the moment just Borates and Lithium

The peak of the Argentinian mining forecasted by media analysis have come on stream, but with some nuances if make reference to the industrial minerals. In general, the percentage of investments in the mining sector has grown enough but the most part in exploration phase and not so much in the realization of projects.

The investments that embrace the projects on the move is significant and have experienced a great growth but is focused in very few projects of great magnitude with millionaire investments and that except in a case, the rest are metallic. The only project of industrial minerals is El Salar del Hombre Muerto of the Minera Altiplano, wholly owned FMC Corp.

Besides, it is necessary to think keeping in mind the Mining Investment Law. How much of that investments is paid by the law and how much is really quantified as private investment?.

Obviously these investments, more or less, indicate that with Mining Investment Law and with the current situation Argentina is an attractive country for the foreing mining companies. The official forecasts point out that before the millennium ends up, the Argentinan mining industry will become the fifth industrial sector of the country whereas 8 years before it didn't figure among the top twenty. How much it will correspond to the industrial minerals?. Until some years it will be a scanty quota and this metallic mining peak will be slow to arrive to the industrial minerals.

The situation of the industrial minerals is not so bouyant. The design of exploitations, product quality and post-sale are in some cases at precarious levels. The companies dedicate very little to the investigation and they don't carry out significant investments because are not considered necessary. The key is that the resources have not a great added value and cannot support the strong necessary investments in Argentina for infrastructures, excepting cases like BÓRAX Argentina, S. R. Minerals and FMC Lithium Corp.

Looking for projects of industrial minerals in Argentina supposes that one of the weak points of the project was the absence of infrastructures, all type of logistical problems and high cost freight. The Government is evaluating the possibility to implant railtrucks of 65 tons. This fact shows clearly as this problem affects to the new projects come on stream. Anyway, the railtrucks need to run on paved roads!

On the other hand, although the provincial governments have unified the

EVOLUTION OF THE ARGENTINEAN MINING SECTOR	1992	1996
Drilling meters for private companies	7.000mts	160.000mts
Drilling meters for state companies	28.000mts	-
Exploration areas	77.000m²	184.000m²
Investment in exploration	< US$10M	US$100M
Total mining investment	US$17M	US$670M
Foreign exploration companies	4	67

PROJECTS 1996-2002	INVESTMENT (US$M)	PRODUCTION (US$M)
Bajo La Alumbrera (Cu-Au)	1.240	470
Salar del Hombre Muerto (lithium)	137	44
Cerro Vanguardia (Au)	198	104
Potasio Río Colorado (K_2O)	150	75
El Pachón (Cu-Mb)	800	320
San Jorge (Cu-Au)	100	25
Loma Blanca (borates)	19	45
Agua Rica (Cu-Au-Mb)	1.000	400
Pirquitas (Sn-Ag)	100	100
Polymetallic projects	25	15
New gold projects	150	50
SME'S investment	344	770

Source: Subsecretaría de Minería

mining procedural rules some problems persist. A document of September 1997 of a business consultant of the Embassy of U.S.A in Argentina Ronald Godard sustained that the Argentinean mining suffered "some grey areas in the legislation are open to judicial interpretation". In reference to the royalties to the counties take the example between Bajo La Alumbrera and the County of Catamarca. They don't come to an agreement how to measure 3% on the "mine-head" value of the mineral extracted that the company should pay to the county; there is quarterly US$5M in game. Although the minister of Economy didn't doubt to intercede in favor of the mining company this type of situations increases the uncertainty. Finally to note the impression of some argentinian lawyers indicating that in some years a cutting will exist on the advantages of Mining Investment Law.

Don't looks for along Chile, just see northwards

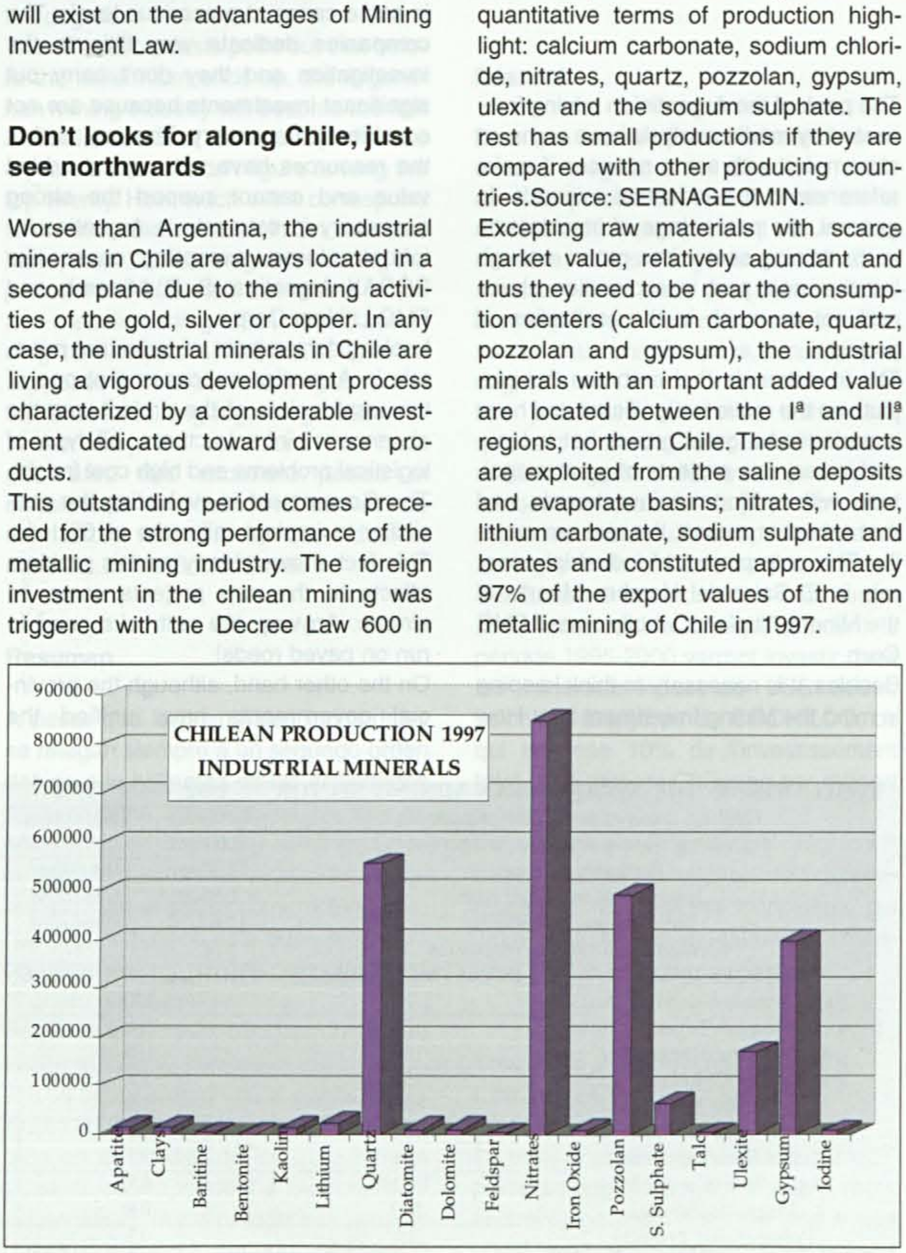
Worse than Argentina, the industrial minerals in Chile are always located in a second plane due to the mining activities of the gold, silver or copper. In any case, the industrial minerals in Chile are living a vigorous development process characterized by a considerable investment dedicated toward diverse products.

This outstanding period comes preceded for the strong performance of the metallic mining industry. The foreign investment in the chilean mining was triggered with the Decree Law 600 in 1974. Finally, further attraction was due to the return to democracy in 1990 that gave economic and political stability.

The chilean situation is easier of analyzing that the Argentina since is centered in some few products and developed among the Iª and VIIIª regions. The patagonian regions are relegated to some sporadic productions for local supplies with products of little specific weight. The statistics of the Chilean Geological Survey describes 34 industrial minerals and are included; those that are in exploitation, that have been exploited although without current production and those that present field evidences being exploited.

In the chart below are showed most of the industrial minerals that at the moment are exploited in Chile, as well as their production during 1997. In quantitative terms of production highlight: calcium carbonate, sodium chloride, nitrates, quartz, pozzolan, gypsum, ulexite and the sodium sulphate. The rest has small productions if they are compared with other producing countries.Source: SERNAGEOMIN.

Excepting raw materials with scarce market value, relatively abundant and thus they need to be near the consumption centers (calcium carbonate, quartz, pozzolan and gypsum), the industrial minerals with an important added value are located between the Iª and IIª regions, northern Chile. These products are exploited from the saline deposits and evaporate basins; nitrates, iodine, lithium carbonate, sodium sulphate and borates and constituted approximately 97% of the export values of the non metallic mining of Chile in 1997.



Source: SERNAGEOMIN.

Summarizing, the industrial minerals with market values and important productions are located between the Iª and IIª regions and correspond to nitrates, iodine, lithium, sodium sulphate and borates. Therefore, these have been the investment targets in the sector with growing investments among 1995-1998. The investments in 1995 were of US$105M, in 1996 of US$222M, in 1997 rose at US$307M and is considered that in 1998 reached about US$256M. Before the decade ends up the estimations of COCHILCO (Copper Chilean Commission) to investments in non metallic mining are around US$210M for 1999 and US$260M in 2000. Among the period 1995-2000 the total investments will reach around US$1.360M and represent 10% of the total mining investments regarding 1997.

These investments are focused in the resources of saline deposits (nitrates, iodine and sodium sulphate), the brines of Atacama (lithium salts, potassium salts and boric acid) and calcium carbonate (cement and lime).

The main projects to count from 1995, already in execution or programmed for the two years are several. In the salitre highlights COSAYACH (investment of US$60M, 95-98); SQM Yodo (investment of US$17M, 1997-1998); SQM Nitratos (investment for US$121M, 95-98) and Cía. Minera Teslin (investment of US$69M, 98-2000). In the Salar de Atacama appears Minsal (wholly owned SQM with an investment of US$264M from 1995 at 1998 and US$27M until the year 2000) and the Sociedad Chilena del Litio with an investment calculated in US$12M between 1996 and 1998. The project of Minera Yolanda (Kap Resources) with an investment of US$116M among 1995-1998 was paralyzed at the end of 1998 due to financial problems.

These investments are reflected in the increasing of production capacities in the Chilean non metallic mining and this evolution is ratified with the production of 1997.

During 1997 the main production increments were in the lithium carbonate 71% (24.200tns), sodium sulphate 45% (64.300tns), Iodine 30% (7.154tns), potassium chloride 13% (434.100tns), nitrates 5% (847.000tns), sodium chloride 36% (5.488.000tns) and ulexite 15% (170.000tns). Also to highlight that the Chilean exports of non metallic products in 1997 reached US$400M FOB, figure record with an increment of 21,8%

FLOW OF INVESTMENTS IN NON METALLIC MINING 1995-2000 (Mill. US$)						
AREA	1995	1996	1997	1998	1999	2000
Saline deposits	63	98	107	105	70	80
Salar de Atacama	40	84	108	51	20	0
Calcium Carbonate	0	40	92	100	120	180
TOTAL (Mill. US$)	105	222	307	256	210	260

Source: COCHILCO

regarding the previous year. The main destination were U.S., Mexico, Canada, Holland, Brazil, Argentina and Peru.

EVOLUTION OF PRODUCTION CAPACITIES OF MAIN NON METALLIC PRODUCTS (Tpy '000)		
PRODUCTs	1995	2000
Nitrates	900	1.770
Sodium Sulphate	50	270
Iodine	6	12
Potassium Chloride	385	685
Potassium Sulphate	0	250
Lithium Carbonate	12	36
Lithium Chloride	0	3
Boric Acid	30	46

Source: COCHILCO

The mining tradition, an advantage

In this situation and with these data the industrial minerals are living a peak and durable moment. The sector, as country of mining tradition, is quite more mature than Argentina and also have the advantage of exploiting products of high added value in the international markets and can enjoy good infrastructures.

The Chilean industrial minerals embraces some few products, with few producers and in a restricted area of the country. This fact reduces the possibilities, but on the other hand the situation is summed up, facilitating a knowledge and detailed pursuit.

Conclusions

Chile is already enjoying an excellent moment for the industrial minerals while Argentina will have to wait that the metallic mining flattens the path to the industrial minerals mainly in infrastructures.

For a foreign company that looks for a project where the export of the final product was essential, the Argentina is expected to offer a range of opportunities very wide whereas in Chile this range is already quite more limited in products and producers. ■

Bedrock quality maps of the Stockholm region, Sweden
Mapas de calidad del sustrato rocoso en la región de Estocolmo, Suecia
Cartes de la qualité du substratum de la région de Stockholm, Suéde

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Abstract

A research project concerning the evaluation of the quality of different rock materials in an area north of Stockholm, Sweden, was initiated in 1991, continuing for three years. The main objective was to establish work procedures in order to evaluate the best use of different rocks as aggregates for the construction of roads and railways and the production of concrete. As a result of this research, a thematic map, a so-called bedrock quality map, has been produced for the densely populated areas of Sweden, starting in the Stockholm region. Investigated rocks are Precambrian, i.e. crystalline rocks. Field investigations were performed and sampling is made on about 45 localities for each map-sheet (625 km^2). Samples were taken for technical and petrographical analyses, including point load testing, and the samples were then classified and the usages established for different purposes, such as roads (pavement), especially bound construction, railway trackbed and concrete.

Resumen

En 1991 se inició un proyecto de investigación acerca de la evaluación de la calidad de diferentes materiales rocosos en la mitad norte de Estocolmo, Suecia, que duraría 3 años.
El objetivo primordial era el de establecer los procedimientos a seguir para la evaluación del mejor uso de las diferentes rocas como Aridos para la construcción de carreteras, balasto y hormigón. Como resultado de esta investigación se elaboró un mapa temático de calidades rocosas para las áreas con mayor población de Estocolmo. Las rocas investigadas corresponden al Precámbrico –rocas cristalinas-. Se realizaron investigaciones de campo y el muestreo se realizó en unas 45 localidades para cada uno de los mapas (625Km2). Las muestras fueron sometidas a análisis técnicos y petrográficos, incluyendo el ensayo de carga puntual, y clasificadas como aptas para usos como: carreteras (pavimento), elementos ligantes en construcción, balasto y hormigón.

Résumé

Résumé : Un projet de recherche concernant l'évaluation de la qualité des différentes formations rocheuses rencontrées dans une zone située au nord de Stockholm, en Suède, a débuté en 1991 et a duré trois ans. L'objectif principal consistait en l'établissement de procédures de travail pour optimiser l'utilisation des différentes roches comme agrégats pour la construction de routes et voies de chemin de fer ainsi que la production de béton.
Résultat de ce projet, une carte thématique, dénommée carte de la qualité du socle, a été élaborée pour les régions de Suède à forte population, en commençant par Stockholm.
Les roches étudiées appartiennent au Précambrien, c'est à dire aux formations cristallines. Les travaux avec analyse d'échantillons ont concerné environ 45 sites par carte (625 km2)
Les échantillons ont fait l'objet d'analyses géotechniques et pétrographiques, y compris l'étude des limites de rupture ; ils ont ensuite été classés en fonction de leur utilisation, en particulier pour les routes (chaussée), les constructions sous contraintes, les voies ferrées et le béton.

1 Introduction

A new thematic map, the bedrock quality map, is complementary to the regular bedrock maps on the scale of 1:50,000 as produced by the Geological Survey of Sweden, SGU. The thematic maps have been developed because of ongoing extensive infrastructural activities. The research, development and methodology was conducted in cooperation with the Swedish National Testing and Research Institute (cf. Persson and Schouenborg 1996). The main purpose of the map is to facilitate the evaluation of the best use of different rocks as aggregates. The first map-sheet (Uppsala SV, 625 km^2) was published in 1998 (Persson 1998a) and is shortly to be followed by two others (Enköping SV and Enköping SO; Persson 1998b, c). Two other map-sheets, Stockholm NV and NO, covering the central parts of Stockholm, will also be published in 1998. In the end of 1998 the map-sheet Västerås SO is also ready. The bedrock quality investigations are based partly on earlier published bedrock maps, which in this region may be modern and of good quality and can be used for this purpose. The area covered by the map-sheets Stockholm NV and NO has been geologically remapped. In the context of infrastructural works in Stockholm, subsurface works such as tunnels, caverns and rock stores are made. Information from some of these underground projects has been collected (cf. Persson 1998d). All information is stored digitally and can be distributed in the form of printed maps, plots and on CD-ROM, the underground information also in three dimensions, 3D (Persson & Morfeldt 1996, Morfeldt & Persson 1997). The excavated rock material from underground projects should be classified and the usages established for different pur-

A new thematic map, the bedrock quality map, is complementary to the regular bedrock maps on the scale of 1:50,000 as produced by the Geological Survey of Sweden, SGU. The thematic maps have been developed because of ongoing extensive infrastructural activities.

poses, eg. roads (pavement), especially bound construction, railway trackbed and concrete (Persson & Schouenborg 1992a, 1992b, 1995, 1996). The methods have been used in consulting reports (Vägverket Region Stockholm 1994). It is intended that other densely populated areas in Sweden will be investigated in the same way. It has also been decided to investigate the Gothenburg area on the Swedish west coast.

2 General geology

Most of the bedrock in Sweden consists of crystalline Precambrian rocks belonging to the Baltic Shield. The rocks in the Stockholm region belong to the Svecofennian orogeny and are in the age range 2000 and 1750 million years (Stålhös 1969). The oldest rocks are of supracrustal (arenites and argillites) origin also including volcanic rocks. These constituents are transformed and metamorphosed in veined gneisses. The oldest plutonics are usually foliated and affected by migmatization. They show a compositional range from gabbro over diorite, tonalite, granodiorite to granite. Feldspar–porphyritic (especially granitic) varieties are common. The youngest plutonic rocks are usually grey or reddish, fine- to medium-grained, massive granites of so-called Stockholm type. They are associated with pegmatites. Thin deformed and folded amphibolitic dykes are common. The structural trends in the region are mainly in directions ENE, NE, E–W, WNW and NW. Dolerite dykes of Jotnian age intersect the Stockholm bedrock in mainly WNW to NW, but also NNW directions (Stålhös 1968, 1969 cf. Persson 1995, Persson & Antal 1996, 1997).

3 Methods

Compilation of the bedrock quality map is based on field checks of the main rock units. About 45 localities on each map-sheet (625 km^2) are selected and approximately 70 kg of rock material from each of them is collected for technical analyses. In addition, a representative rock boulder (approximately 50x40x40 cm) for point load testing is sampled. As some of the rocks are heterogeneous, e.g. the veined gneisses, locally more than one sample is taken (denoted A, B, C etc). Thin sections and petrographic analyses are produced from each locality. The orientations of joints and sets of joints are measured. In these investigations the jointing is estimated, i.e.number of joints per metre (cf. Deere 1968). Unsuccessful attempts were earlier made by us to use the Q-value (Barton 1976, Barton et al. 1974) at road-cuts. Stereograms with plotted representative joint orientations from most localities are presented.

The rock material is crushed twice to produce a flakiness index (Swedish) between 1.30 and 1.40. The test methods used are those recommended by the different public authorities concerned in Sweden. The radiation (^{238}U, ^{232}Th and ^{40}K) from different rock types in the outcrops is measured using a scintillometer and spectrometer. Special attention is paid to the occurrence of sulphides, graphite and alkali silica reactive material.

An interpretation of lineaments is made. For this purpose the topographical database at the scale of 1:50,000 is used. Lineaments are also interpreted from anomalies on the aeromagnetic and aeroelectromagnetic (VLF) maps. The VLF map shows electrically conductive horizons in the bedrock, e.g. water- or graphite-bearing zones. On the bedrock quality map, structural trends of schistosities are presented.

The rock material for technical analyses is taken using a sledge-hammer, from quarries and blasted road-cuts. The material is first crushed in a gyratory crusher with 30 mm exit aperture and then in a laboratory jaw crusher with 16 mm exit aperture (cf. FAS-metod 221-95). The Nordic test for studded tyres (FAS-metod 259-95) is performed at SGU and the analysed fraction mesures 11.2–16 mm. The Los Angeles Test is performed at the Swedish National Testing and Research Institute. The stone material is crushed and screened (using a flake-sorting sieve with 6.3 mm aperture) in order to obtain flakiness indexes (Swedish) of about 1.30 to 1.40 (FAS-metod 209-94). The LA values are then determined, using an analysed fraction of 10–14 mm according to the future European standard (cf. FAS-metod 210-89). Cores with a diameter of 45 mm are drilled from boulders and tested in a BEMEK rock tester at the SGU to determine the point load index. The testing is done both parallel with and perpendicular to the deformation structures of the rock. Approximately 10 measurements are performed in each direction (Broch & Franklin 1972, ISRM 1985). Thin sections of all rock types are studied under a polarizing microscope. Concerning alkali silica reactivity (ASR) the following division is made: 1, no risk; 2, probably no risk; 3, small risk; and 4, evident risk (most quartz grains are severely deformed). The deformation of the quartz crystals is studied (cf. West 1996). The mineralogy and modal contents are also determined. In particular, the quartz and mica contents, and the existence of sulphides and graphite are noted. The radiation from different rock types is measured in the field. A scintillometer and a spectrometer are used to measure ^{238}U, ^{232}Th and ^{40}K and the total gamma radiation in the outcrops. From this information, the radium index is calculated. This index is recommended not to exceed a value of 1.0 (cf. Åkerblom 1990, Åkerblom et al. 1990). Generally speaking, younger granites and pegmatites in this region can have high values of U and Th, especially the latter.

A quality classification of each sample is then performed. The rock samples are classified for three purposes: pavement construction (mainly wearing courses), railway trackbed construction, and concrete (cf. Persson & Schouenborg 1996). The classification of the rock material for roads (pavements) is based on the requirements of the Swedish National Road Administration (VÄG 94), where the material is divided into three classes based mainly on the studded tyre test, petrographic analysis, and brittleness (LA values). The use of aggregate as railway ballast is restricted to two classes, good and poor (requirements are stipulated by the Swedish National Railway Administration; SJ 1988, Banverket 1996. Relevant parameters are petrographic composition, mainly the quartz and mica contents, water absorption, and the LA value. The quality classification for concrete is in three classses and concerns petrographic analysis, mineral composition, grain size, grain boundaries, structure, porosity, the degree of weathering and the occurrence of sulphides and alkali-reactive material, in this case mainly highly deformed quartz (cf. BBK 94, Swedish Concrete Association, SS 13 21 25). A classification for protective stone, e.g. at harbours, has also been taken into consideration (CIRIA SP 83). Important parameters in this case are point load index, density, and water absorption.

An overall areal quality classification is made. Areas judged as class 1 (good), class 2 (average), and class 3 (less suitable) rock quality are distinguished. The classification is based mainly on the results of studded tyre tests in relation to the requirements of the Swedish National Road Administration (VÄG 94). The results of the other technical analyses are also evaluated and integrated. The best rock quality class (1) has for example studded tyre test values below 10%, Los Angeles values below 15% and point load indices above 8 MPa. Serious geological weakness zones in bedrock are avoided and jointing must be low. Class 1 material is good used as road surface material and railway ballast. Class 2 material has some of above-mentioned properties, but not all. It may be used either as road surface material or as railway ballast. Class 3 material generally has poor properties. Very mica-rich sedimentary gneisses, mica schists, some amphibolites and pegmatites may occur in this class.

4 Results

Technical analyses from samples in the Stockholm region have been performed. Hitherto, more than 220 Nordic studded tyre tests, 100 Los Angeles tests and about 60 point load values, both perpendicular to and parallel with the schistosity, have been made. Comparisons have also been made with the great number of analyses from different parts of Sweden provided by Stenlid (1996).

The foliated granites, granodiorites and tonalites have studded tyre test values ranging between 6.8% and 19.5% (Table 1); the mean values between 11.0 and 12.8%. The younger, more or less massive granites show values between 5.5% and 16.6% (mean value 11.8%). Some fine-grained granite types consequently are more wear-resistant. Some of the metavolcanics produce low values (3.5%) and the upper limit is 14.4% (mean value 9.6%). The greenstones have a mean value of 17.2%, varying between 10.8% and 30.1%. The latter value is from a weathered rock type. It is obvious that minerals such as biotite, hornblende and pyroxene make the rock softer and more susceptible to weathering and wear. Regarding the sedimentary gneisses as a whole, they are a heterogeneous category, providing both good and bad values (cf. Table 1); the mean value is 15.6% (range 7.0–27.1%). The quartz- and feldspar-rich rock types (greywackes) can be as good as many of the fine-grained granitoids. Some younger, very narrow, dense dolerite dykes produce very low studded tyre test values.

The foliated granodiorites and tonalites show Los Angeles values (Table 1) in the range between 13.8 – 22.9% (mean values 18.2% and 17.5% respectively). The foliated granites have a wider range, viz. 14.1 – 28.9% (mean value 21.0%). Many of the greenstones can be quite durable (mean value 16.7%; range 14.0 – 21.7%). The metavolcanics are even more durable (mean value 13.2%). The sedimentary gneisses show a great heterogeneity, giving values between 9.6% and 29.4% (mean value 19.0%). There is a great difference in competence between quartz–feldspar and mica-rich types. The younger, massive granites are relatively brittle; the mean LA value is 22.0%. The granites vary between 13.2% and 29.6%. Presence of mica may to a limited degree produce good LA values. The LA values of fine-grained rock types are also relatively better than those of coarse-grained types.

The point load tests reveal the hetereogeniety of the rock material in an excellent way (Table 2).

The younger granites are generally massive, displaying a low anisotropy (1.1) and good values in both directions (mean values 9.4 and 8.3 MPa, perpendicular to vis-à-vis parallel with the foliation). The gneissic (foliated) granites,

Rock type	Studded tyre test, %			Los Angeles value, %		
	Range	Mean value	Number	Range	Mean value	Number
Foliated granites	6.8–19.5	12.8	53	14.1–28.9	21.0	22
Foliated grano-diorites	6.8–15.3	11.0	27	14.4–22.9	18.2	9
Foliated tonalites	7.7–16.2	12.1	26	13.8–22.7	17.5	18
Greenstones	10.8–30.1	17.2	16	14.0–21.7	16.7	9
Metavol-canic rocks	3.5–14.4	9.6	11	12.1–14.1	13.2	3
Veined gneisses	7.0–27.1	15.6	11	9.6–29.4	19.0	35
Younger granites	5.5–16.6	11.8	27	13.2–29.6	22.0	13

Table 1. Studded tyre tests and Los Angeles values (%) for different rock types from the Stockholm area..

granodiorites and tonalites have lower mean values (8.0–8.5 and 6.5–7.6 MPa) and a greater anisotropy (1.3). The individual values may be even higher. The greenstones have the highest anisotropy (1.8) and show high values perpendicular to the foliation (mean value 9.6 MPa). The metavolcanics have a slightly lower anisotropy (1.4) but their mean values are higher (9.8 vs. 7.1 MPa). The sedimentary gneisses show the same anisotropy (1.4) but their mean values perpendicular to and parallel with the foliation are lower (8.6 and 6.7 MPa respectively). Thus, the most foliated and veined rocks, i.e. the metavolcanics, greenstones (also amphibolites) and the sedimentary gneisses, can produce a high strength perpendicular to the foliation, e.g. mica layers, but are weaker parallel with these layers. The quartz- and feldspar-rich rock types (metavolcanics) have a generally greater strength.

5 Conclusions

The production of bedrock quality maps is now under way in the Stockholm region, Sweden. In these investigations different rock types of an outcrop are sampled and the published results therefore do not coincide completely with those of industrially produced material comprising the whole occurrence. The latter is a mixture of different rock types. Moreover, the material is treated in order to obtain the best possible quality, e.g. crushing in many stages. The investigations are made in this way in order to gain a thorough knowledge of the properties of the various rock types and the variations within different rocks. Quality maps present general ideas about the possibility of using bedrock as aggregates. A detailed investigation (prospecting and planning) must be made before the excavation of rock material is started. These investigations are hopefully a helpful tool for the planners and extractors of aggregate materials.

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Rock type	Point load tests, MPa			
	I_{s50} ⊥	I_{s50} //	Anisotropy, I_a	Number
Foliated granites	8.38	6.74	1.30	13
Foliated grano-diorites	8.54	6.49	1.38	10
Foliated tonalites	7.99	7.64	1.17	11
Greenstones	9.57	5.33	1.78	6
Metavolcanics	9.83	7.07	1.42	3

Table 2. Mean values of point load tests (MPa) on different rock types from the Stockholm region.

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Mechanical precut method in tunnelling
El método de precorte mecánico
El método de precorte mecánico

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Abstract

This paper deals with a new auto-sustaining tunnelling method in soils or soft formations called **Mechanical Pre-cut**. This method has the ability to maintain the radial tension state of the formation and the stability of the tunnel front while tunnelling by using a pre-lining mobile structure.

Resumen

La excavación de un túnel en una formación, tipo suelo o roca blanda, produce una perturbación debida a la eliminación del material, que en esquema se puede interpretar como la tendencia del propio material a rellenar el hueco producido. Cada material, dependiendo de sus características reológicas, adquirirá un estado de fluencia, más o menos rápida, que en un análisis tridimensional se puede describir como una tendencia a rellenar el hueco por el frente de excavación y por el perímetro lateral de la misma. Este estado de fluencia produce un reajuste de las tensiones naturales de la formación atravesada por el túnel, a lo largo del tiempo, hasta llegar a un nuevo equilibrio.

Los métodos tradicionales de sostenimiento que son utilizados para contrarrestar este fenómeno y por tanto mantener la sección geométrica, se han centrado en producir un obstáculo a la fluencia del terreno mediante mecanismos colocados "a posteriori" , tales como cimbras, gunita, bulones etc. y por lo tanto son elementos que entran en servicio cuando el terreno ya ha iniciado su movimiento.

Si somos capaces de producir un elemento suficientemente rígido "antes" de producir el hueco debido a la excavación, éste impedirá el movimiento de fluxión del material en la dirección perpendicular a la superficie de este revestimiento previo, manteniendo en consecuencia un estado tensional muy similar al del estado original, dentro de la formación. Las tensiones puestas en juego se reducen así a las producidas por la propia deformación elástica de este prerevestimiento y las convergencias posteriores, al realizar la excavación de la sección, se reducen al mínimo.

Tal y como se ha indicado anteriormente, la naturaleza del problema es tridimensional por lo que al mismo tiempo que se suministra un sostenimiento en sentido radial, debe procurarse una estabilización del frente del túnel.

En parte, la tendencia a fluir el material del frente se contrarresta por el hecho de mantener una parte de este prerevestimiento sin excavar en los sucesivos avances, de manera que una porción del terreno limítrofe al labio exterior del mismo, no pueda fluir hacia adentro. El resto del material, que tendería a fluir por el centro del frente y por la solera, debe ser estabilizado también al avance. En formaciones con fuerte rozamiento interno suele ser suficiente establecer un "machón central" o berma de terreno al realizar la excavación de la sección, que consigue esta estabilización por un simple equilibrio de las fuerzas puestas en juego. En otro tipo de formaciones, con características más claramente plásticas, pueden requerirse tratamientos rigidizantes al avance tales como la colocación de bulones o pernos de PRFV diseñados de forma divergente hacia afuera (efecto "corcho de champán").

Un elemento importante de estabilización es la eliminación del agua presente en la formación por delante del frente. Según las condiciones del acuífero y de la formación del terreno se pueden realizar drenes al avance, abatimientos previos, tratamientos de impermeabilización etc. La construcción de este prerevestimiento, al que se ha hecho mención, se lleva a cabo con la realización del Método de Precorte Mecánico.

Résumé

L'article fait état d'une nouvelle technique de creusement dans les formations meubles ou tendres à l'aide d'un tunnelier auto-portant, technique appelée "Pré-coupe mécanique". La méthode a l'avantage de pouvoir maintenir le degré de tension radiale de la formation et la stabilité du front de taille pendant le creusement par l'utilisation d'une structure mobile de revêtement préalable.

El Método de Precorte Mecánico (PREMILL·) se enmarca dentro de los métodos denominados de pre-sostenimiento al avance, especialmente idóneos para la ejecución de túneles en formaciones tipo suelo o de rocas blandas y en entornos urbanos o semiurbanos, debido a la mínima afección que producen en las estructuras y servicios situados por encima de la clave.

Fundamentos del metodo

Descripcion general

Al Método de Precorte Mecánico (PREMILL·) se enmarca dentro de los métodos denominados de pre-sostenimiento al avance, especialmente idóneos para la ejecución de túneles en formaciones tipo suelo o de rocas blandas y en entornos urbanos o semiurbanos, debido a la mínima afección que producen en las estructuras y servicios situados por encima de la clave. Por otra parte, con el Método de Precorte Mecánico, se produce un confinamiento del

Figura 1: Máquina de precorte mecánico.

frente de excavación, previo a la realización de la misma, con indudables ventajas añadidas de cara a la estabilidad del mismo.

La aplicación del Método fuera de nuestro país presenta múltiples realizaciones a lo largo de los últimos 20 años, mientras que en en España la primera obra se llevó a cabo en el año 1.992 (Túnel de El Goloso).

El Método de Precorte Mecánico o de revestimiento previo a la excavación, consiste en la realización de un corte al avance a partir del frente del túnel, siguiendo el perímetro de la sección del mismo. La ranura de corte así obtenida se rellena, simultáneamente a la operación de corte, con un hormigón proyectado de fraguado rápido, realizado por vía seca o húmeda, obteniéndose de esta manera una bóveda rígida estabilizante. Las operaciones de corte y relleno de la ranura resultante se llevan a cabo con una máquina específica construida al efecto, **Fig. 1**. La puesta en obra del revestimiento definitivo se realiza posteriormente contra las bóvedas del pre-revestimiento ejecutadas.

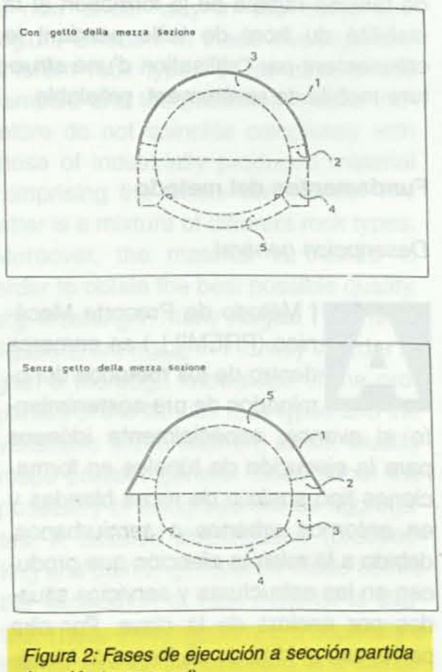


Figura 2: Fases de ejecución a sección partida (sección transversal).

Características y ejecucion de la prebóveda

Las prebóvedas que se construyen suelen tener un espesor variable entre 14 y 30 cm. y una longitud de hasta 5 m. Cada tramo de precorte tiene una forma ligeramente troncocónica para permitir la ejecución de los tramos sucesivos y la realización del revestimento final del túnel. La longitud de los tramos o pases se establece en función de las características geomecánicas del terreno y de la sección del túnel a construir. Lo mismo sucede con el espesor de hormigón de la prebóveda.

Los tramos de prebóveda tienen un solape entre sí de al menos 50 cm. con el fin de dar una continuidad longitudinal a los mismos a lo largo del túnel y proporcionar un funcionamiento estructural adecuado. La bóveda estabilizante o prebóveda se realiza a lo largo de todo el perímetro de la sección, por elementos transversales sucesivos y de longitud variable en función de las características "in situ" del terreno y de las condiciones hidrogeológicas presentes. Cada tramo transversal de corte se rellena inmediatamente de hormigón antes de proceder al corte del siguiente, realizándose un serrado previo de este hormigón fresco con el fin de conseguir una correcta unión entre los sucesivos tramos a lo largo de todo el perímetro de la sección. Dada la elevada velocidad de avance del corte

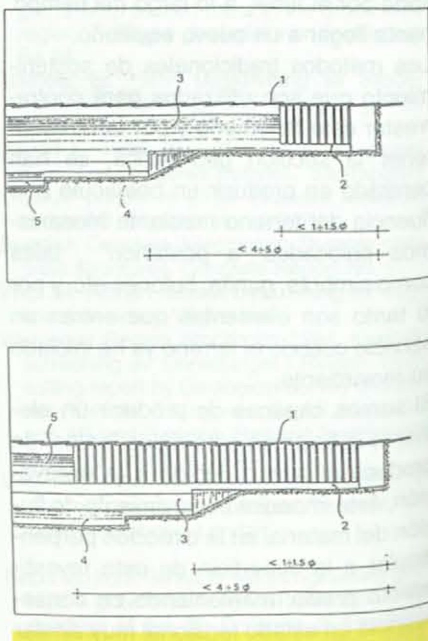


Figura 3: Fases de ejecución a sección partida (sección longitudinal).

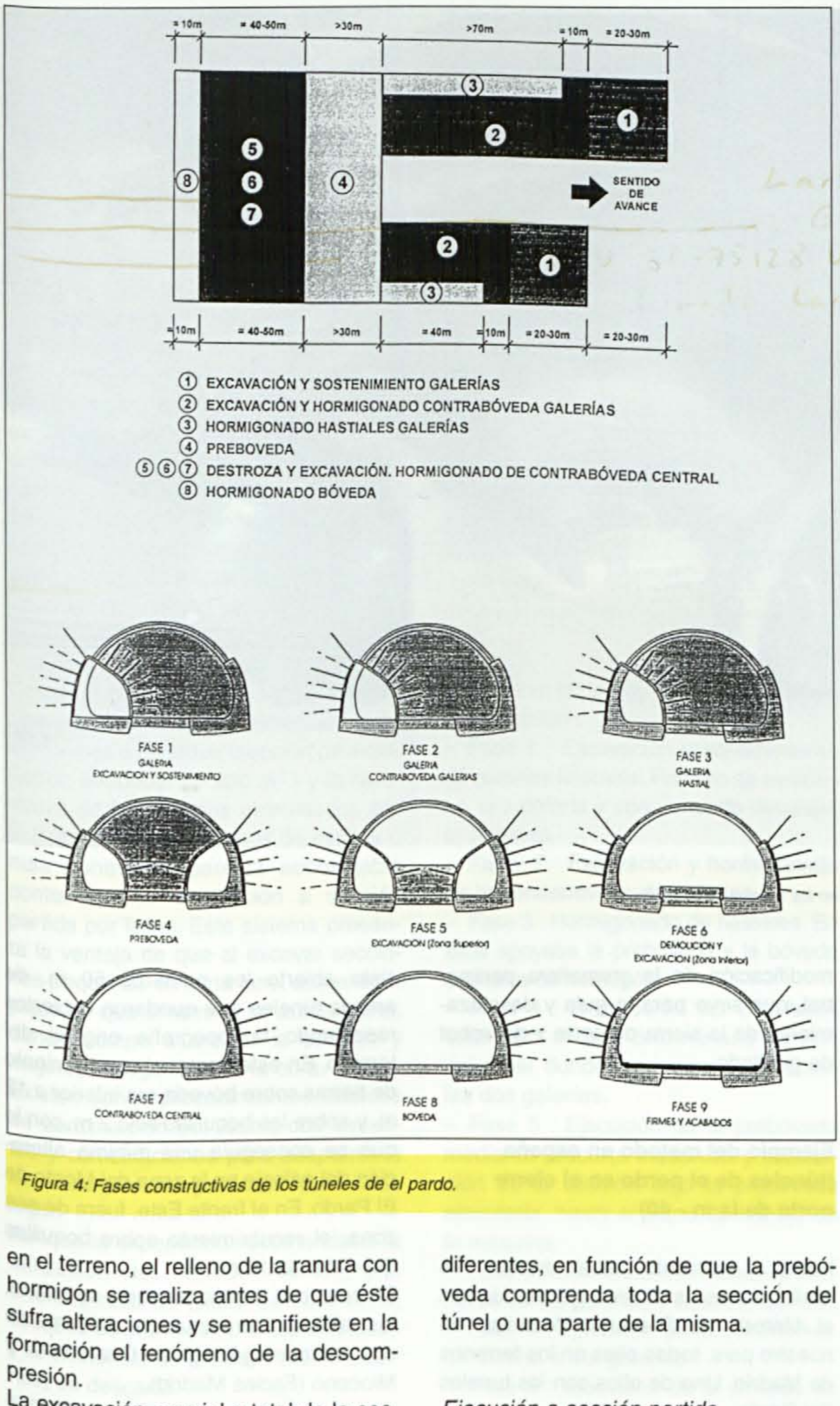


Figura 4: Fases constructivas de los túneles de el pardo.

en el terreno, el relleno de la ranura con hormigón se realiza antes de que éste sufra alteraciones y se manifieste en la formación el fenómeno de la descompresión.

La excavación, parcial o total de la sección, puede avanzar al alcanzar el hormigón de las prebóvedas una resistencia tal que le confiera el carácter de elemento autoresistente para las cargas puestas en juego. Estas resistencias suelen ser del orden de 8 a 10 Mpa., que con los materiales y aditivos utilizados se suelen alcanzar en un tiempo de unas 4 horas.

Diferentes sistemas de ejecución

El Método de Precorte Mecánico se puede aplicar según dos esquemas diferentes, en función de que la prebóveda comprenda toda la sección del túnel o una parte de la misma.

Ejecución a sección partida

Su ventaja fundamental se basa en el hecho de tener una altura de frente de excavación reducida. Por otro lado, el efecto portante consecuencia de la forma circular de la prebóveda, es mermado por la falta de cierre de la estructura. Normalmente, deben asociarse en estos casos al pre-revestimiento unos elementos de sostenimiento complementarios.

Dentro de este sistema de ejecución, caben dos esquemas de trabajo, según que el revestimiento definitivo de la bóveda se ejecute antes o después de la realización de la contrabóveda, Figs. 2 y 3.

En el primero de los casos las fases constructivas serían :

Fase 1 : Ejecución de la prebóveda y excavación de la sección al abrigo de la misma.

Fase 2 : Hormigonado de la parte de hastiales correspondiente a la sección de avance.

Fase 3 : Hormigonado del revestimiento definitivo de la bóveda.

Fase 4 : Excavación necesaria en destroza y hormigonado del resto de los hastiales.

Fase 5 : Ejecución de la contrabóveda.

En el segundo de los casos las fases constructivas serían :

Fases 1 y 2 : Idénticas al caso anterior.

Fase 3 : Igual a Fase 4 del caso anterior.

Fase 4 : Igual a Fase 5 del caso anterior.

Fase 5 : Igual a Fase 3 del caso anterior.

Ejecución a plena sección

La ventaja principal de este esquema constructivo se deriva por un lado de la gran rapidez de ejecución del túnel y por otro de que el pre-revestimiento, debido a un mejor efecto arco, conjuntamente al efecto de confinamiento del terreno, contribuye a una reducción de los asientos.

Las fases constructivas en el caso de ejecución a plena sección son las siguientes:

Fase 1 : Ejecución de la prebóveda y excavación de la sección al abrigo de la misma.

Fase 2 : Ejecución de los hastiales.

Fase 3 : Ejecución de la contrabóveda.

Fase 4 : Hormigonado del revestimiento definitivo de la bóveda.

Este sistema de ejecución requiere un análisis de la estabilidad del frente. Caso de que el frente resulte inestable se puede recurrir, en la excavación de la sección, a mantener una porción del mismo inclinado sobre la vertical a modo de "machón" o berma a modo de contrafuerte o bien, si la inestabilidad es más marcada, se procede a la estabilización del mismo.

Ventajas del metodo

Dentro de su ámbito de aplicación, el Método de Precorte Mecánico presenta una serie de ventajas :

– *Conservación de las características del terreno que rodea a la excavación,* por un relleno inmediato con hormigón de elevadas prestaciones.

Figura 5: detalle de prebóvedas y galerías de avance en los túneles de el pardo.

– *Eliminación prácticamente total del sobreperfil,* debido a la gran regularidad de la ranura y al riguroso posicionamiento de la máquina de corte y gunitado, lo que se traduce en unos excesos mínimos de hormigón en el revestimiento definitivo del túnel.
– *Reducción de la incidencia de los entibados,* sustituidos por la prebóveda de hormigón.
– *Aumento de la seguridad para el personal de obra en el frente,* dado que trabajan al abrigo de una bóveda autoresistente, así como para *las estructuras y servicios situados por encima del túnel,* por la limitación y reducción de asientos.
– *Aumento importante de la velocidad de avance,* con posibilidad de excavación a plena sección y empleo de más de una máquina trabajando en varios frentes.
– *Reducida inversión en equipos,* en comparación con otros métodos de maquinaria integral, con una *incorporación a la obra prácticamente inmediata* (de 2 a 3 meses como máximo en el caso de una máquina nueva) lo que hace al método especialmente competitivo en tramos cortos, frente a aquellos.
– *Mayor capacidad de adaptación que las máquinas integrales a todo tipo de secciones,* ya que sólo es necesaria la modificación de la cremallera perimetral, que sirve para la guía y desplazamiento de la sierra de corte y del robot de gunitado.

Ejemplo del metodo en españa (túneles de el pardo en el cierre norte de la m - 40)

Hasta el momento actual, existen tres realizaciones de túneles ejecutados con el Método de Precorte Mecánico en nuestro país, todas ellas en los terrenos de Madrid. Uno de ellos son los tuneles del Pardo.

Debido a que los terrenos atravesados eran considerados de alto valor ecológico, histórico, paisajístico y cultural, se decidió atravesar en túnel la mayor parte posible del trazado de la M-40 por el Monte de El Pardo. Una solución de autopista a cielo abierto habría llevado a desmontes de más de 30 m.

Asumida la solución en túnel bajo el Monte de El Pardo se rebajó la pendiente de la rasante, manteniéndose por debajo del 3% durante la mayor parte del túnel para conseguir las mejores condiciones de explotación.

En el frente Oeste, se construyeron a cielo abierto los primeros 50 m. de ambos túneles que quedaron cubiertos reponiendo la topografía original del terreno. En este tramo, el recubrimiento de tierras sobre bóveda era inferior a 12 m. y sobre las boquillas sólo 2 m. con lo que se conseguía una mínima alteración del paisaje en la zona del Monte de El Pardo. En el frente Este, fuera de esa zona, el recubrimiento sobre boquillas quedaba de 10 m.

En cuanto al terreno presente se refiere, los túneles atravesaban únicamente dos unidades geológicas: Cuaternario y Mioceno (Facies Madrid).

Con respecto a los materiales cuaternarios, se reconocían limos eólicos y gravas eolizadas de carácter periglacial en las terrazas media y baja, así como abundantes aportes laterales.

Los materiales más característicos atravesados por la traza de los túneles correspondían a la Facies Madrid del Mioceno, que procede de la destrucción de los granitos y gneises de la Sierra de Guadarrama. En el conjunto detrítico se distinguen dos unidades que localmente la unidad superior, más arenosa, es conocida como "arena de miga" y la inferior, con un mayor contenido de arcilla, como "tosco", si bien existe una transición gradual de uno a otro material variando la proporción de finos. Es frecuente encontrar en el nivel de la arena de miga capas más arcillosas, que no suelen sobrepasar los dos metros de potencia y que en el nivel de tosco existan capas más arenosas. Otras características de estas unidades son su cementación y la preconsolidación por erosión y desecación a que han estado sometidas. Ambas causas dotan a los materiales de gran compacidad.

En cuanto a la hidrogeología de la zona se refiere, es conocido que en Madrid existe un acuífero general profundo conectado con el aluvial del río Manzanares.

En la zona de El Pardo debido a una serie de pozos el nivel freático está deprimido de 10 a 20 m bajo el nivel del río Manzanares. Existen pequeños acuíferos colgados con presiones hidrostáticas reducidas.

Desde el comienzo del diseño se tuvo presente que dadas las dimensiones de los túneles a construir (sección de excavación alrededor de 200 m^2.) y la naturaleza de los terrenos atravesados por la traza (en algunos casos de escasa o nula cohesión), parecía aconsejable contemplar su excavación a sección partida por fases. Este sistema presenta la ventaja de que al excavar secciones pequeñas en cada fase, aumenta el plazo en que el terreno se autosoporta, dando tiempo a entibar la sección y mejorar la seguridad de la obra.

Existen varios procedimientos clásicos de construcción por fases, con variantes y combinaciones para adaptarse a las circunstancias particulares de cada lugar.

Aunque la experiencia recomendaba la utilización del Método Alemán, por diversas razones (plazo de obra corto, escasez de mano de obra especializada y la existencia de métodos más modernos) se descartó.

La solución final adoptada partía de la filosofía del Método Alemán, en cuanto a partición de la sección, pero realizando la excavación y sostenimiento de dos galerías de avance laterales en cada túnel según el Nuevo Método Austriaco y la bóveda central según el Método de Precorte Mecánico mediante la ejecución de una prebóveda, previa a la excavación, apoyada sobre los hastiales de hormigón de las galerías. Se hizo así porque se entendía que cumplía con suficientes garantías los condicionantes técnicos, de plazo y de seguridad requeridos, como así sucedió efectivamente.

Las fases en que se dividió la ejecución

Figura 6: Máquina de precorte mecánico en los túneles de s. germain-en-laye.

se detallan en la **Fig. 4** y se describen a continuación :

– Fase 1 : Excavación y sostenimiento de galerías laterales. Primero se excavaba una galería y con un cierto decalaje, la segunda.

– Fase 2 : Excavación y hormigonado de la contrabóveda de galerías.

– Fase 3 : Hormigonado de hastiales. En ellos apoyaba la prebóveda y la bóveda definitiva de hormigón.

– Fase 4 : Representa las tres fases anteriores en una determinada sección del túnel donde se hayan completado las dos galerías.

– Fase 5 : Ejecución de la prebóveda mediante precorte mecánico y excavación de la sección bajo la prebóveda ejecutada, hasta el plano de trabajo de la máquina.

– Fase 6 : Demolición de hastiales interiores de las galerías y destroza central.

– Fase 7 : Ejecución de la contrabóveda central entre galerías.

– Fase 8 : Ejecución de la bóveda de hormigón definitiva.

– Fase 9 : Recrecido de contrabóveda y ejecución del firme.

Antes del comienzo de las galerías se realizó un paraguas de Jet-Grouting de 15 m. de longitud, contorneando todo el perímetro de la bóveda de los túneles así como la mitad superior de los hastiales de galerías. Como obra adicional, en la boca Oeste de los túneles, se ejecutaron unas viseras de protección a base de cerchas, chapa Bernold y hormigón, ante posibles desprendimientos del talud del frente, que no obstante se sometió un tratamiento de hormigón proyectado.

Vamos a describir la Fase 5, por tratar el tema que nos ocupa. La ejecución de la bóveda en la parte central del túnel, se llevó a cabo realizando en primer lugar una prebóveda de hormigón proyectado mediante el Método de Precorte Mecánico que se ha descrito anteriormente. La prebóveda realizada previamente contribuye con su resistencia al dimensionamiento global del revestimiento definitivo, lo que permitió optimizar el espesor del mismo en la obra. Fig. 5.

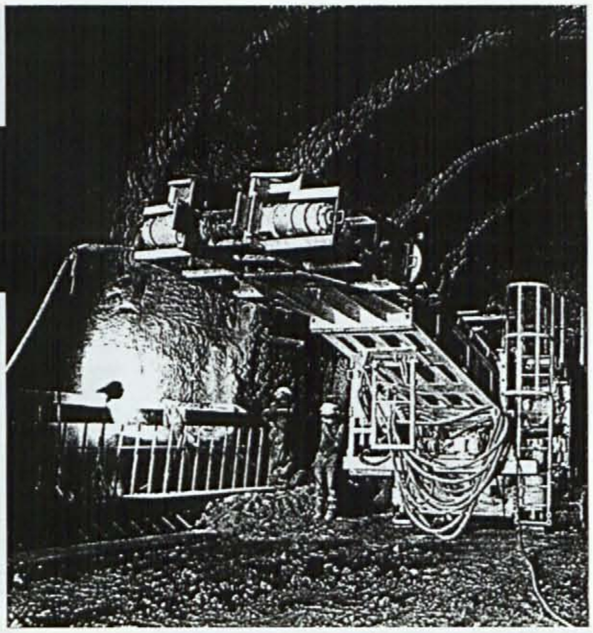
El frente de precorte se llevaba a una distancia entre 30 y 50 m. del hastial de hormigón de galería más retrasado. La resistencia exigida al hormigón proyectado de la prebóveda era en nuestro caso de 8 a 9 Mpa.

En la obra se utilizaban dos máquinas de corte denominadas equipos PREMILL-1 y PREMILL-2, que trabajaban cada una en un túnel. Las sierras de corte de ambas máquinas, fabricadas expresamente para esta obra, eran de doble cadena.

La diferencia fundamental entre los dos equipos radica en el sistema de desplazamiento y posicionamiento, en el movimiento longitudinal de la sierra de corte con respecto a la estructura general y en el desplazamiento transversal del robot de gunitado con respecto a la sierra de corte.

La excavación de las tierras al abrigo de la prebóveda se realizaba con una retroexcavadora de ruedas y dado que las dimensiones de la sección en el frente lo permitían, la carga del material se llevó a cabo con una cargadora de ruedas, que cargaba el cazo y marcha atrás transportaba el material, pasando

A14 le tunnel de Saint-Germain-en-Laye



PHASAGES ET CONSTRUCTION

Les principales phases de construction du tunnel foré de Saint-Germain sont les suivantes :

1 - Réalisation de la prévoûte de soutènement provisoire et excavation.

•

2 - Contre voûte et banquette.

•

3 - Étanchéité.

•

4 - Bétonnage de la voûte.

•

5 - Chaussées - Équipements.

phase 1

Réalisation de la prévoûte de soutènement provisoire et excavation

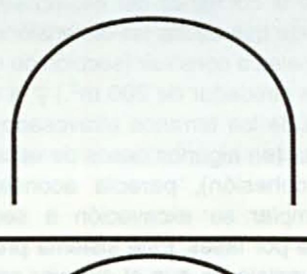
Au niveau du front, l'avancement est réalisé en deux phases

1-Exécution de la prévoûte

Une haveuse spécialement conçue pour ce tunnel et sa géométrie, permet de réaliser une saignée de profondeur 3 à 5 m dont l'épaisseur varie de 17 à 24 cm. Cette saignée est remplie de béton projeté par voie mouillée à l'aide d'un robot intégré à la machine haveuse.

2-Excavation

Après échange des machines à front, l'excavation et le marinage sont réalisés à l'aide d'une machine à attaque ponctuelle PAURAT (E 249).
Ces travaux sont réalisés à l'abri de la prévoûte. Les matériaux sont alors évacués le jour à l'extérieur du tunnel par des dumpers TEREX de 13 m³.
Le rythme d'avancement de cet atelier est de l'ordre de 2 prévoûtes par jour (6 à 10 ml/jour).



phase 2

Contre-voûte et banquette

Un radier de contre-voûte est réalisé sur les 180 premiers mètres à l'Est du tunnel creusé, dans la zone concernée par le sable de cuise. Au-delà, le radier n'étant plus nécessaire, des banquettes sont réalisées par un atelier qui suit le front à une distance d'environ 150 m.

Ces banquettes, assurent la fondation des efforts provenant de la voûte qui sera réalisée. Elles servent d'appui et de guide pour le coffrage de la voûte.

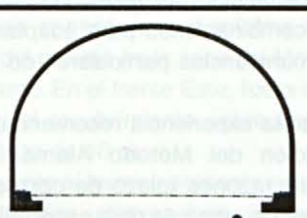
Le béton utilisé est un CPJ B25.

phase 3

Étanchéité

Un complexe composé d'un géotextile et d'une membrane PVC d'une épaisseur de 1,5 millimètres constitue l'étanchéité d'extrados de la voûte. Il est plaqué contre les prévoûtes avant bétonnage de la voûte. Un portique spécifique a été réalisé pour cette opération.

Les eaux sont ainsi drainées à la base de la voûte dans les drains latéraux qui sont reliés tous les 100 m à l'assainissement général.

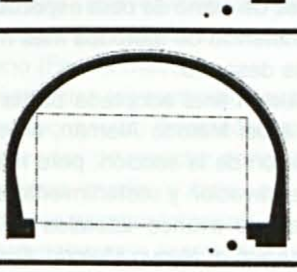


phase 4

Voûte définitive

Le revêtement définitif est réalisé par un béton coffré à l'aide d'un outil coffrant de 12 m de long.

Cet atelier, situé à 200 m du front, avance à un rythme de 30 à 40 m par semaine.



phase 5

Chaussées Équipements

La chaussée du tunnel différente de celle mise en œuvre sur le reste du tracé (chaussée souple GB/BB) sera constituée soit de béton armé continu (B.A.C.) soit d'enrobé à module élevé (E.M.E).

Six mois seront nécessaires après la fin du génie civil pour mettre en place l'ensemble des équipements et réaliser les essais avant la mise en service de l'autoroute.

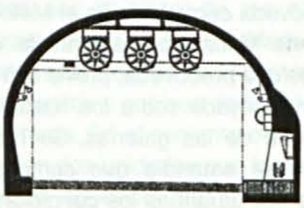


Figura 7: Fases de ejecución de los túneles de Saint Germain-en-laye.

por debajo de la máquina de corte, hasta la zona donde se situaban los camiones de transporte, de tipo convencional.

También a una distancia de 30 a 50 m. de las prebóvedas, se procedía a la demolición del hastial interior de las galerías, ya que una vez realizada la excavación descrita en el apartado anterior (incluyendo los bulones de fibra de vidrio) se limitaba a una "cáscara" de gunita que actuaba como puntal de la parte superior de las mismas.

El equipo PREMILL-1, al ser una máquina nueva y con varias innovaciones, resultó inevitable una fase de correcciones, puesta a punto, coordinación y mejora de ejecución de otras unidades del propio túnel (apoyos de la prebóveda en las galerías).

Los trabajos de precorte se llevaron a cabo continuadamente durante cuatro meses, momento en el que se detectaron unas anomalías en los hastiales de hormigón de las galerías laterales en la zona de la boquilla Este, por delante del frente en ese momento. Con el fin de adoptar las medidas de seguridad oportunas, se decidió parar el avance del equipo de Precorte Mecánico hasta que dichas medidas estuviesen concluidas. El equipo PREMILL-2, trabajó a ritmo uniforme hasta la terminación del túnel. El encofrado de la bóveda se diseñó con un sólo carro de 10 m. de longitud, para la ejecución de ambos túneles, ya que el número de puestas semanales (2-3) permitían ejecutar primero un túnel y luego el otro.

Según la instrumentación que se instaló para la obra, el máximo asiento en clave medido fue de 10 mm., comprobándose a su vez que los movimientos se iniciaban cuando el frente se encontraba a unos dos diámetros de la sección de control, siendo el movimiento al paso del frente del orden del 50 % del asiento total. En lo que respecta a las convergencias de la prebóveda, los valores medidos se situaron en la franja entre 1 y 2 mm.. La estabilización de las medidas de convergencias se producía entre 10 y 20 m. de distancia al frente.

Ejemplo del método en el extranjero (túneles de «saint germain-en-laye»)

Las realizaciones de túneles con el Método de Precorte Mecánico fuera de nuestro país son múltiples a lo largo de las dos últimas décadas. Un ejemplo son los túneles de Saint Germain-en-Laye.

La autopista que une el barrio de la Défense en París, con la población de Orgeval al Oeste de la región Parisina, atraviesa el bosque público de Saint Germain-en-Laye. Con el objeto de preservar el paisaje y dadas las características de entorno protegido de la zona, se construyó un túnel de 2.810 m. de longitud, de los cuales 955 m. se realizaban en falso túnel, quedando una longitud de 1.855 m. de túnel en mina.

Cada túnel paralelo tiene una sección interior de 75 m^2 (90 m^2 de sección de excavación) con un ancho de calzada de 9,5 m. (11,03 m. entre hastiales). Los dos túneles tienen una separación entre ejes de 28 m.

El entorno geológico estaba constituido por las típicas formaciones de la cuenca Parisina. Estas formaciones eran homogéneas y subhorizontales, con un ligero buzamiento hacia el Norte. La serie de formaciones son las siguientes:

– De 1 a 3 m. de aluviones antiguos y formaciones recientes.

– Aproximadamente 6 m. de arenas de "Beauchamp".

– Aproximadamente 10 m. de margas calizas.

– Aproximadamente 15 m. de calizas fracturadas.

– Aproximadamente 8 m. de arenas de "Cuise".

La mayor parte de los túneles se excavaba en las calizas fracturadas (resistencia a compresión de 8 a 15 Mpa.), mientras que hacia el Este la solera cortaba a la formación de las arenas de "Cuise", donde se asentaba el nivel freático.

Con objeto de afectar lo menos posible al entorno, la boca Oeste se prolongó hasta una cobertura de unos 8 m., atravesando por completo el estrato de margas calizas y rozando la formación de las arenas de "Beauchamp".

Para la ejecución de los túneles se eligió el Método de Precorte Mecánico, a plena sección, Fig. 6, y para la excavación posterior al abrigo de la prebóveda se utilizó una máquina de ataque puntual (rozadora).

Normalmente las prebóvedas tenían un espesor de 20 cm. (mínimo 17 y máximo 24 cm.) y una longitud entre 3 y 5 m. El hormigón proyectado de las prebóvedas se realizaba por vía húmeda, al mismo tiempo que se le añadía un agente estabilizante y un superplastificante. En la boquilla de proyección se inyectaba un activador de fraguado, de manera que se aseguraba una resistencia de 6 Mpa. a las 4 horas. La excavación de la sección se realizaba con una rozadora de 300 Kw. de potencia en cabeza y 120 Tn de peso.

Por detrás de las dos fases anteriores se ejecutaban las demás operaciones de la construcción del túnel, es decir el hormigonado de la bóveda y de la contrabóveda (sólo en la zona de arenas). Para el hormigonado de la bóveda se utilizaba un carro de encofrado deslizante de 12 m. de longitud, que se posicionaba sobre dos bancadas laterales, hormigonadas en una fase anterior. Merece destacarse el hecho de que debido a la gran regularidad de las prebóvedas, los "tapes" del encofrado se realizaban mediante un tubo de material hinchable. Todas estas fases de ejecución se detallan en la Fig. 7.

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Gotthard base tunnel
El túnel de Gotthard
Le tracé du tunnel du Gotthard

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Abstract

The new railway base tunnel through the Gotthard in the central part of the Swiss Alps has a length of about 57 km. This tunnel will cross mainly hard crystalline rocks belonging to the Pre Triassic basement. During the Alpine orogeny the formations traversed have undergone a regional metamorphism increasing from north to south. Main failure structures (boundaries, schistosity) are steep and perpendicular to the tunnel. More than 85% of the tunnel will encounter fair to good rock conditions. Poor rock quality and squeezing rocks will be met in some small sedimentary zones of Permocarboniferous and/or Mesozoic age as well as in one zone with intensively deformed cataclastic rocks which has to be related to a late phase of the Alpine orogeny. Investigations include exploration by deep drilling in critical zones (Tavetscher intermediate massif and Piora zone) with core logging, core tests in laboratory. There exists therefore - before the beginning of the work - a serious knowledge of the geological and geotechnical conditions concerned.

Resumen

El nuevo túnel de ferrocarril a través del Gotthard en la parte central de los Alpes suizos tiene una longitud de unos 57 km. Dicho tunel atravesará fundamentalmente rocas cristalinas duras del basamento pre-Triásico. Durante la orogenia Alpina las formaciones atravesadas han sufrido un metamorfismo regional más intenso hacia el sur. Las principales estructuras (límites, esquistosidad) son muy inclinadas y perpendiculares al túnel. Más del 85% del túnel se encontrará con litologías de calidad adecuada. Se encontrarán rocas de baja calidad en algunas zonas reducidas del permocarbonífero y/o del Mesozoico así como en una zona con rocas cataclásticas muy deformadas que se han relacionada con una fase tardía del la orogenia Alpina. Las investigaciones realizadas incluyen sondeos profundos en zonas críticas (macizo intermedio de Tavetscher y zona de Piora) con recuperación de testigo y ensayos de los testigos en el laboratorio. Existe por lo tanto, antes del comienzo de los trabajos, un amplio conocimiento de las condiciones geológicas y geotécnicas del terreno a atravesar.

Résumé

Le tracé du nouveau tunnel ferroviaire traversant le massif du Gotthard, dans la partie centrale des Alpes suisses a une longueur d'environ 57 kilomètres.Ce tunnel traversera principalement des roches cristallines dures, appartenant au socle triasique. Pendant l'orogénèse alpine, les formations rencontrées ont été soumises à un métamorphisme régional d'amplitude croissante du nord vers le sud. Les principales zones de faiblesse (contact lithologique, zones de schistes) sont affectées d'un fort pendage et recoupent perpendiculairement le tracé du tunnel. Sur plus de 85% du tracé, la qualité du rocher est satisfaisante à bonne.On rencontrera une qualité de rocher médiocre avec présence de roches écrasées, au niveau de quelques secteurs sédimentaires étroits, rattachés au Permocarbonifère et/ou au Secondaire, et aussi, à hauteur d'une zone avec des formations cataclastiques trés déformées qui doivent être corrélées à une phase tardive de l'orogénèse alpine. Les études comprennent une exploration par forage profond dans les zones critiques (la zone moyenne du massif de Tavetscher et celle de Piora) avec carottage et analyse des échantillons en laboratoire. On dispose donc -avant le commencement des travaux- de données précises sur les conditions géologiques et géotechniques qui prévalent.

1. Introduction, the project

The Gotthard railway base tunnel has a length of about 57 km and will cross the central massifs of Swiss Alps. The railway tunnel systems consists of two single-track tunnels with a diameter of about 9.4 m, connected by cross-passages at intervals of about 325 m and two crossovers and emergency stop stations. The northern portal Erstfeld lies at 462 m a.s.l on the height of Swiss Midlands, the culminating point at 550 m a.s.l. and the southern portal Bodio at 313 m a.s.l. somewhat higher as the Po Plain in Italy. For constructional means the base tunnel was divided in five sections (see situation fig.1):

– Erstfeld (7.4 km)
– Amsteg (11.4 km) with access gallery (2 km)
– Sedrun (6.2 km) with access gallery (1 km) and a 800 m deep vertical shaft
– Faido (15.1 km) with access gallery (2.6 km)
– Bodio (16.6 km)

Contractors have the possibility to bid for the excavation blasting or boring methods, except for the section Sedrun where only conventional blasting method is allowed. Both Portal zones con-

The Gotthard railway base tunnel has a length of about 57 km and will cross the central massifs of Swiss Alps. The railway tunnel systems consists of two single-track tunnels with a diameter of about 9.4 m, connected by cross-passages at intervals of about 325 m and two crossovers and emergency stop stations.

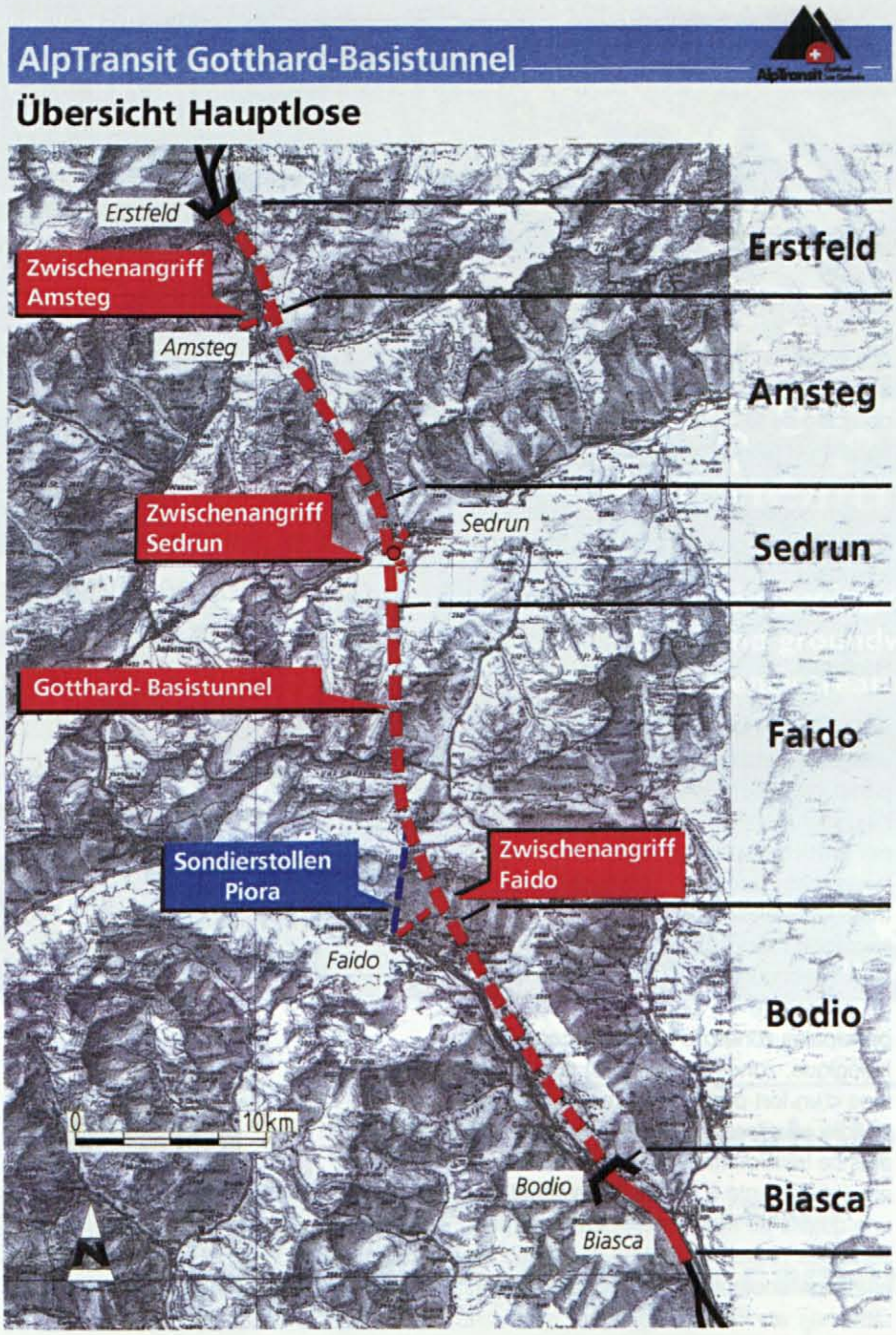

Fig 1: Situation of the Gotthard base tunnel with main sections and intermediate attacks (Zwischenangriff) (picture AlpTransit Gotthard AG).

tain a short cut and cover tunnel and an excavation of soils before reaching rock surface.

The intermediate attack of section Sedrun lies on the critical path of time schedule and the access gallery had exploratory character regarding the cross-over station. Therefore work at Sedrun began in 1996. Access galleries will start in 1999/2000 and main tunnel sections in 2001/2.

2. Geological situation

The Gotthard base tunnel will cross mainly Pre Triassic crystalline basement belonging to several tectonic units: namely to the two central massifs of the Aar and of the Gotthard, to the intermediate Tavetscher massif (Zwischenmassiv) and finally the Penninic gneiss region (or Lepontine gneiss region). The massifs are separated by small zones of Mesozoic sediments (Urseren-Garvera zone, Piora zone) or fault zones (Clavaniev/ Disentiser zone)

The succession of tectonic units is seen in figure 2.

The Pre Triassic basement consists of three main groups of crystalline rocks (Labhart 1977):

- Variscan and older polymetamorphic gneisses and migmatites
- Late Variscan Plutonite (granites, granodiorites, syenites), 270 - 330 mill.years
- Small wedges of pyroclastics and detritic rocks of Permocarbo-niferous age (ª 300 mill.years)

The sedimentary zones separating the massifs contain Permocar-boniferous - Mesozoic in the case of the Urseren-Garvera zone and Mesozoic (Triassic - Jurassic) in the case of the Piora zone.

During Alpine orogeny the basement and the cover were affected by selective strain and a late regional syn- to postkinematic regional metamorphism of Barrowian type. The latter was high (amphibolite facies) near the south portal and up to the southern rim of the Gotthard massif and decreased to the north. So the rocks in the Sedrun region are in the range of greenschist facies, while the northern part of the Aar massif was not affected by Alpine metamorphism. The observed alteration in the northernmost part of the Aar massif (chloritisation) may be older than Alpine (Late Variscan retrograde metamorphism).

Listing up the different rock types expected in the actual project we get the following distribution:

3. Geotechnical conditions

3.1. General situation and investigations

Prediction of the geology and geotechnical conditions is facilitated by the fact that the deep valleys and mountains along the trace of the base tunnel furnish numerous outcrops. In addition the behaviour of most rock types is known from studies of former underground excavations in the region (road galleries, old Gotthard railway tunnel (Keller et al 1987), galleries for power plants, military caverns).

All main structures, namely the boundaries of the tectonic units as well as the Alpine schistosity and most of the faults in the Aar and the Gotthard massif, are steep and perpendicular to the tunnel. Therefore the orientation of the most important geotechnical discontinuities and failures in the rock masses are favourable for tunnelling.

More than 85% are hard rocks. Therefore rock masses with fair to good quality will dominate.

The overburden thickness reach a maximum of 2600 m with the consequence that shear failure and even rockburst may occur in all massifs with poorly join-

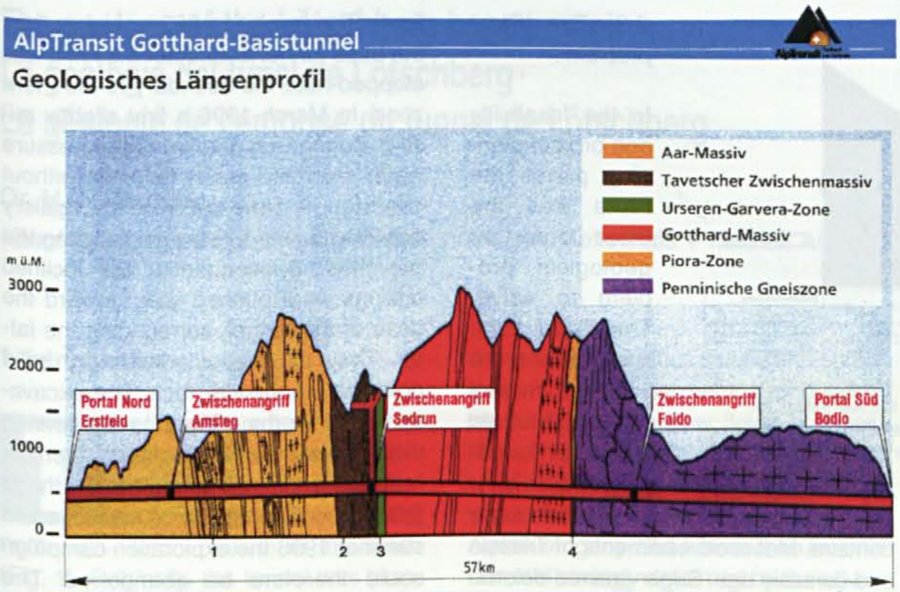

Fig.2: Schematic geological section through the railway base tunnel. Units with expected geotechnical problems are: 1 = Permocarboniferous Intschi zone, 2 = Clavaniev zone and northern part of Tavetscher intermediate massif with a high content of cataclastics, and squeezing rocks (see details fig. 4), 3 = sedimentary Mesozoic and Permocarboniferous Urseren-Garvera zone, 4 Mesozoic Piora zone (see fig.

Rock type	Length (m)	shear (%)
Soil	1'040	1.8
Alternation rock/soil (Erstfeld)	945	1.7
Mesozoic (Jurassic, Triassic)	315	0.6
Permocarboniferous pyroclastic, mainly schist, phyllites	2'050	3.6
Strongly sheared/broken during Alpine orogeny,	1445	2.5
Variscan Plutonites Aar- and Gotthard massif	5'710	10.1
Variscan Plutonites Penninic (Leventina - Granitgneiss)	17'570	31.0
Migmatites, migmatitic gneisses	10'360	18.3
Polymetamorphic gneisses of paragneiss type, amphibolites	12'315	21.7
Late Ordovician granitoids (Streifengneis)	4'915	8.7
Total	56'665	100.1

Table 1: Distribution of rock types.

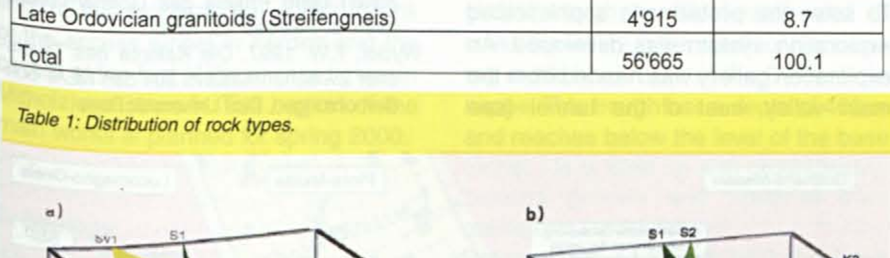

Fig. 3: Schematic 3-D diagram with relationship between schistosity and tunnel bore. a) Variscan structures (sv) dominating, few alpine planes of schistosity (s1) (Erstfelder Gneis, km 102.1 – 104.0); b) alpine schistosities s1, s2 and joints K1, K2 in late Variscan Aare granite.

ted rock masses. On the other hand the rock temperature will raise to about 40°C requiring special cooling for tunnel work. Very poor to poor rock quality is expected in all zones which where affected by late postmetamorphic movements during Alpine orogeny. In an early stage of investigations all superficial fault-structures were mapped and recorded in a register for this reason (Schneider 1997). Post glacial faults with recent and still active uplifts of the valley side represent a special problem. High precision levelling show in some cases an uplift of 0.5 - 0.7 mm/year (Eckardt et al 1983).

One of the zones with an intensive alpine strain and only a weak alpine metamorphism is the faulted Intschi zone, containing geotechnically unfavourable phyllitic and coal schists. This zone was recently traversed with a tunnel boring machine for the Amsteg power plant without extraordinary problems. Therefore the Intschi zone needs no special investigations concerning the AlpTransit tunnel project.

The Urseren-Garvera zone is another geotechnically difficult stretch. Rock quality experiences have been made during the excavation of the Gotthard road tunnel, of the old Gotthard railway tunnel and in a gallery situated just above the Gotthard base tunnel. Therefore no exploration drilling was carried out.

Special investigations were required on both portal sides where the tunnel will partly penetrate blocky quartarny soils with groundwater. For this reason 35 vertical and inclined boreholes of a length of 10 - 72 m were brought down at Erstfeld in the north and 9 boreholes of 25 - 80 m in the south at Bodio.

The northern part of the Tavetscher intermediate massif (Zwischenmassiv) and the Piora zone played a decisive part in the project. The latter on was even dragged into the political scene (Zbinden & Kellenberger 1998). Both zones called for a serious and sophisticated survey as will be shown in the next two chapters.

3.2. Squeezing rocks in the northern part of the Tavetscher Zwischenmassiv

At Sedrun strongly weathered rocks are widely covered by soil. This suggests that the bedrock is weak and has poor tunnelling quality. These rocks belong to the northern part of the Tavetscher intermediate massif (Zwischenmassiv) for-

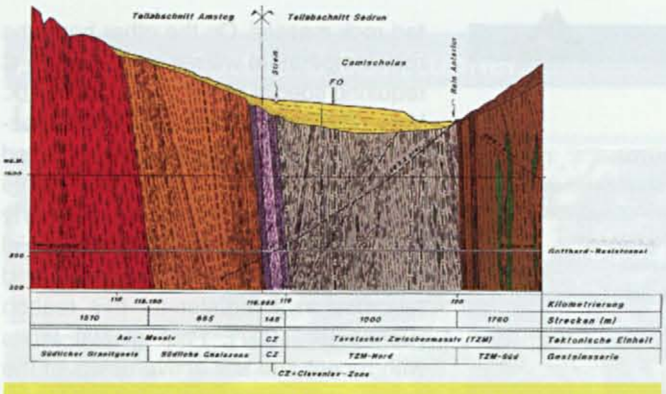

Fig 4. Longitudinal section through the transition from the Aar massif (at left) into the Tavetscher intermediate massif (Tavetscher Zwischenmassiv) with the 1715 m long deep drilling SB 3.2 crossing the Clavaniev zone at the level of the Gotthard base tunnel.

ming a small and elongated body of old polymetamorphic crystalline rocks situated between the Aar massif in the north and the Gotthard massif in the south. According to several authors this area represents the roots of the Helvetic calcareous naps.

The southernmost part of the Aar massif and the northern part of the Tavetscher intermediate massif (Zwischenmassiv) had undergone strong deformation. Rock masses were sheared of and fractured and cut by several faults, most of them parallel to the main Alpine structures. Because of lacking outcrops it was very important to have better knowledge of the length and the character of the zone, also in order to get a better estimate of costs and of the duration to get through with the tunnel. A series of inclined deep drillings was executed (Amberg et al 1998).

The last one (SB 3.2), of 1715 m length, crosses the border to the Aar massif near the projected tunnel. The situation is shown in figure 4. According to those results the tunnel should pass south of the Aar massif in a 145 m wide zone of extremely sheared rocks with two faults of 30 - 40 m width and a high content of fault gauge. The so called "Clavaniev-Zone" is heading over to the east into the Disentiser zone with Mesozoic sediments. Subsequently the tunnel will encounter 1000 m of the northern Tavetscher intermediate massif with sheared cataclastic schists and several faults are found in SB 3.2. Cataclastic rocks of very poor tunnelling quality have a proportion of about 60%. Smectit as clay minerals and inclusions in quartz indicate that last deformations took place at 9 - 11 Ma, by 190°C and 0.6 kbar (Wyder 1997).

To summarize the tunnel will meet south of the Aar massif squeezing rocks on a total length of 1145 m.

3.3. The Piora problem

In the feasibility and project planning phase the Piora was the most important geological problem to solve. The Piora zone is separating the Gotthard massif and Penninic gneisses (Lucomagno-Gneise). This small zone contains Mesozoic sediments of Triassic and Jurassic age. Sugar-grained dolomite (zuckerkörniger Dolomit) belonging to the Middle Triassic occurs in different outcrops. This cohesionless material behaves like water-bearing sand. An old power plant gallery was flooded with water saturated material of this type which impeded the further work for a long time. Therefore a two folded question arose. The first one, related to the structure of the Piora zone, was; "Is the Piora zone a simple syncline which pinches out above the tunnel level or is the Piora zone a deep reaching thrusted plane and in its worst case bends back to the south and follows the tunnel trace? In the literature one finds as many answers as there are authors. The second question, related to the quality of the rock, was: "In case the Piora zone reaches the tunnel level, in what form the material appear?" To solve the problems a sophisticated exploration system was developed. An exploration gallery was headed from the main valley west of the tunnel (see fig.1). The level was 350 m higher than the base tunnel level. After 5.5 km it was stopped near the boundary to the Piora zone. In March 1996 a first slightly raising boring run into a high pressure water saturated grainy dolomite without cohesion. A blow out in to the gallery occurred due to a failure in handling the preventer. Subsequently four inclined drillings were pushed down toward the base of the tunnel, surrounding the latter. They all encountered a dry solid dolomite - anhydrite rock. The excavation risks for the railway base tunnel in this zone are also not higher than anywhere else. Normal tunnelling methods (blasting or boring) can be envisaged. In summer 1998 the exploration campaign could therefore be abandoned. The whole Piora zone exploration system comprised 26 borings, 6 of them longer than 500 m, the longest (SB 4.5) reached 1073 m. The railway base tunnel will have to cross the Piora zone on a length of 135 m, see figure 5).

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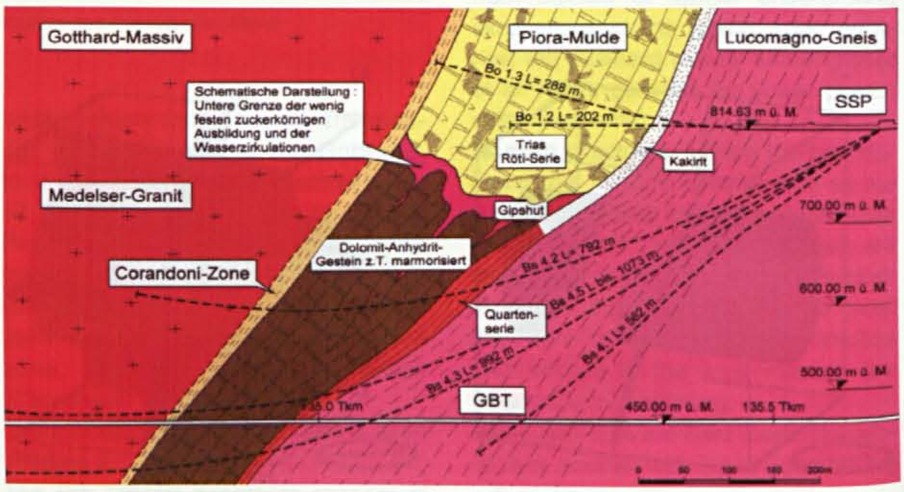

Figure 5: The Piora exploration system. Longitudinal section in the area of the Gotthard base tunnel - exploration gallery (SSP) with deep drillings BS 4.1. - BS 4.5 crossing the Piora zone. Light yellow = sugar grained dolomite; brown = compact solid dolomite-anhydrite rock, pink = transition zone with gypsum. (picture Ingenieurgemeinschaft Gotthard-Basistunnel Süd).

The geology of the Lötschberg base tunnel
La geología del túnel de Lötschberg
La géologie de l'emprise du tunnel de Lötschberg

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(Geologengruppe Lötschberg-Basistunnel, p.A. Kellerhals + Haefeli AG, Bern)

1. Introduction

The Lötschberg base tunnel as part of AlpTransit in Switzerland is 34.5 km long and connect Frutigen (Berne) in the north with Raron (Valais) in the south (Fig. 1). Originally, the tunnel was planned with two fully equiped tubes but due to the financial problems the project has been retouched. But on account of safety reasons, however the base tunnel will be construct of the hole distance with two tubes. Between Frutigen and the foot of the access tunnel Mitholz with the planned service stop, the constructed exploration tunnel Kandertal will be used as a safety tunnel. In the next section between Mitholz and Ferden, two tubes will be constructed, but only the east tunnel will be equiped for the railway. In the last section from Ferden to Raron two tubes will be constructed and equiped. With the lateral accesses to the intermediate working points in Mitholz, Ferden and Steg, the Lötschberg base tunnel will be devided into sections for optimum con-struction time and engineering. In this moment, the constructions of the access tunnel in Ferden and the cavern at the feet of the access tunnel in Mitholz are in work. The beginn of the main works is planned for spring 2000.

2. Geology

In the northernmost 13 km between its north portal at Frutigen and the Gasterntal the Lötschberg base tunnel traverses a variety of successive Helvetic deposition sediments. After that it remain up to the south portal in Raron in the entire Aar massif, including the northern Autochthon, the Jungfrau wedge and the southern autochthonous sediments (Autochthonous of Gampel-Baltschieder, Fig. 2).

From the portal at Frutigen, the base tunnel pass first in a distance of about 4.3 km a Flysch complex with Taveyannaz sandstones. This northern part is very inhomo-geneous and consists of argillaceous and calcareous shales and sandstones with frequent vertical and lateral interbedding. Up to now, it was not possible to find out the origin of all the involved units. This sediment rock accumulation was emplaced at an early stage of the Alpine orogeny and where then overridden and strongly deformed by the advancing helvetic Wildhorn nappe.

After this undefined Flysch deposits the tunnel reachs the Wildhorn nappe and enters after approx 5 km in the adjoining argillaceous Flysch of the Doldenhorn nappe. The Wildhorn nappe is a well stratified or cleft and partly strongly fissured sequence of slates and limestones. This slates and the mentioned flyschs are generally low permeable but gas-bearing (methane). Since the base tunnel will run near or cross the flat-lying basal thrust zone of the Wildhorn nappe, the 9.5 km long exploration tunnel was driven to investigate the structure and technical behaviour of the rocks in detail (results see TEUSCHER et al. 1998).

The base tunnel drive round Kandersteg on the west side in a large curve. With this lineation its possible to evade the glacial trough by Kandersteg and to cross the valley in the south of Kandersteg in the hard rocks of the Doldenhorn nappe. This trough has a depth of 400 m and reaches below the level of the base tunnel. He is filled up with groundwater-bearing gravels and material from prehistoric landslides.

Between km 11.2 and 14.0 the base tunnel passes the core of the Doldenhorn nappe consisting of limestones and marly shales. Thes limestones are supposed to be partly karstic and strongly waterbearing (with water pressures up to 60 bar). The base of this nappe is marked by a 3 m thick nearly cohesionsless kakirite. Next to this main thrust follows the autochthonous cover of the cristalline Aar massif with around 500 m of strongly sliced triassic dolomites, shales, anhydrites etc..

The Gasterntal, also a glacial trough filled up with gravel and sands will be passed within the hard rock with sufficent distance to the watersaturated valley till (checked by drillholes, Fig. 2).

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Near km 14.5 the northern border of the cristalline Aar massif is reached with the Gastern granite. This granitic body, which is cutted with the base tunnel over a length of about 7 km, and also the more southern Central Aar granite and the Baltschieder granodiorite represent large Variscan granitoids. They intruded into the steep diping gneisses and schistes (with subordinate amphibolittes) of the so-called „Altkristallin". Special attention was given of the investigation of the Carboniferous, a thin and nearly vertical zone with anthracite-bearing shales, quartzites etc. and to the so-called „Jungfrau wedge", a strongly deformed syncline with metamorphic sediments of triassic-jurassic age. As checked by a 1405 m long inclined drillhole this wedge measures only about 50 m at the level of the base tunnel and shows a very low permeability. Furthermore there are two important thrust zones („Dornbach" and „Faldumbach") with thick phyllites (up to 30 m). This thrust zones was also investigated with long inclined and cored drillholes.

At the southern border of the Aar massif the tunnel passes through the Autochthonous of Gampel-Baltschieder, another part of the original sediment cover of

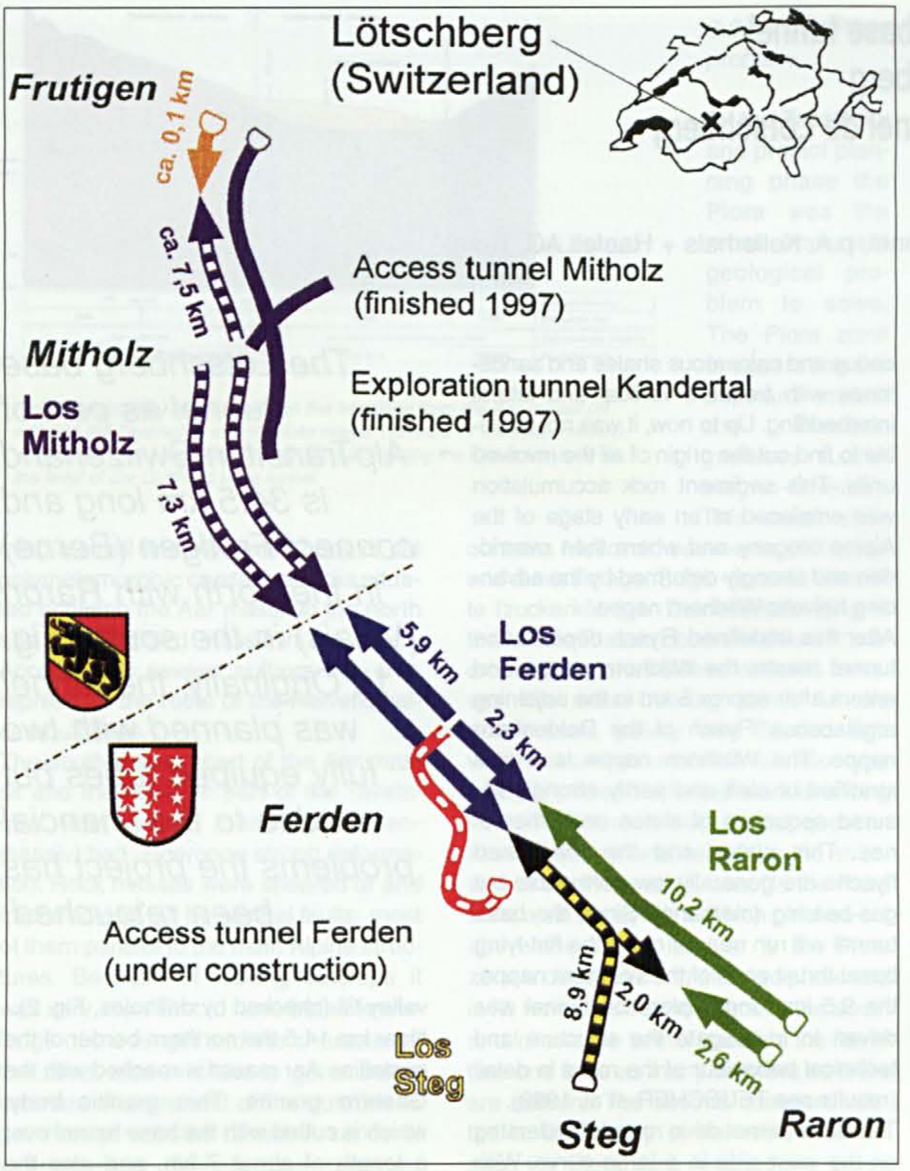

Fig. 1. Situation.

the bedrock. It comprises a pile of limestones and marly shales with malm-liassic age and a 280 m thick complex zone of strongly tectonised slices with mainly triassic sediments (dolomites, shales, carneules etc.). Near the southern portal basement rocks (gneisses) appear again bordering the vast alluvial plain of the Rhone valley.

3. Geotecnical remarks

In the last 8 years would be done very many investigations for this project (geophysics, geologische Kartierungen, drillholes with in-situ tests, laboratorium tests, etc.). The details of this investigations including the geological-geotecnical prognostic can be found in KELLERHALS et al. 1998.

4. Acknownledgments

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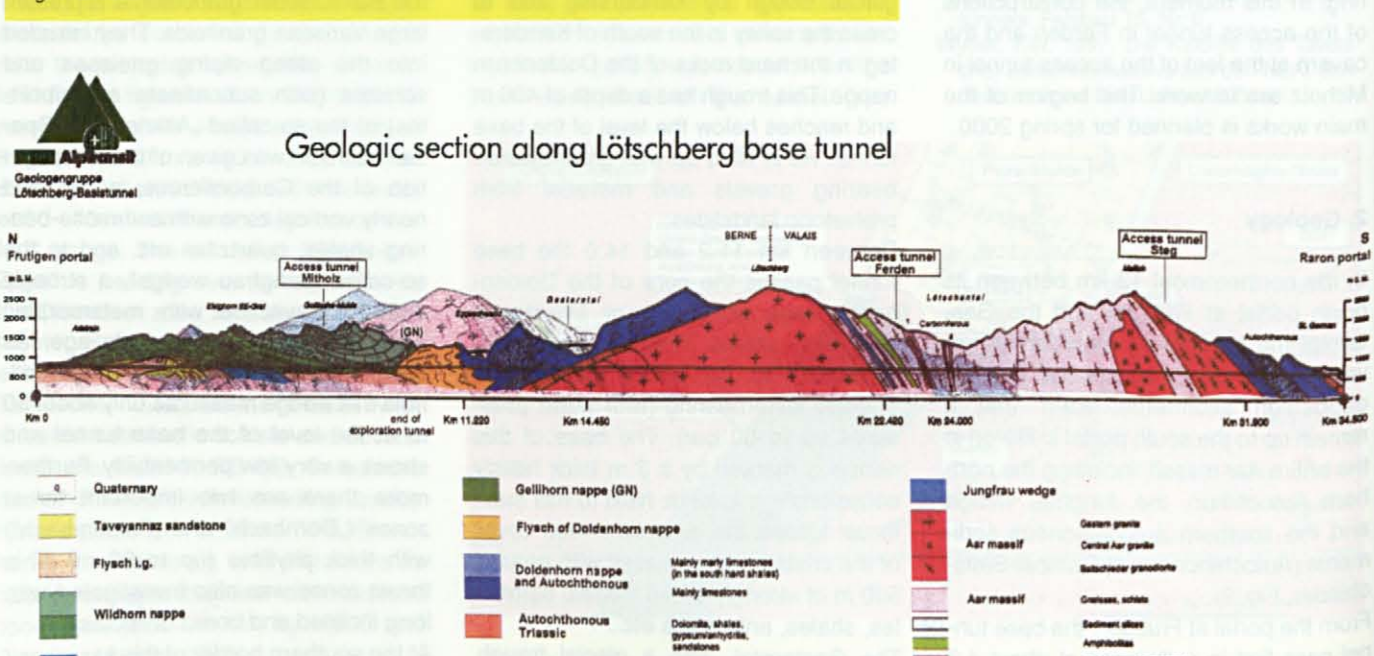


Fig. 2. Geologic cross section.

European Federation of Geologists 1996-1999: up and away
La Federación Europea de Geólogos 1996-1999: hacia arriba y más allá
Fédération Européenne des Geologues 1996-1999: réalités actuelles et passées

Manuel Regueiro
Past President of the EFG

Abstract

The author reviews the activities and achievements of the EFG during the last three years

Resumen

El autor repasa las actividades y logros de la FEG durante los últimos tres años

Résumé

L'auteur analyse les activités et les réalisations de la FEG, ces trois dernières années

Last year in Budapest the Council of the EFG appointed a new Board leaded by Gareth Jones, its former Vice-President. This ended a long period (1994- 1999) in which Spain has had different posts in the Board of the EFG, culminated by the last three years in which I have held the post of EFG President.

These last three years have seen a significant advance in the consolidation of the organisation, both from the organising point of view and from the representation of the European geologists, media presence and diffusion of professional geology.

At Budapest I made a balance of this last EFG years, pointing out the fulfilment of the proposed objectives included in the plan presented by Spain (ICOG) when I assumed the responsibility of managing the EFG. Most of this results are due to the combined effort made by all the Board members during this years, the generosity of some member associations and a series of individual Council representatives that provided the time and support to achieve the proposed goals. My warmest thanks to all of them.

A summary of such balance is included below.

Since 1996, the EFG has increased its **members** from **12 to 19**, a significant **58%** growth. The EFG **budget** has gone from **192 000 FF** in **1996** to **336 000 FF** in **1999**, a **75%** increase, although **member fees** that in **1996** represented **145 000 FF** have only increased to **168 000 FF**, that is a **13.5%** increase in 4 years (**3.3% pa**), this resulting from the growing impact of extraordinary activities (particularly the European Geologist magazine) in the EFG budget.

The review of EFG activities displayed in the first place the main foundational objectives of the EFG:

• Represent the geological profession in Europe. CGEU representative body in the EU
• Affirm the professional identity of geologist in Europe
• Safeguard and promote the interests of the geological profession in Europe
• Guarantee free movement of geologist in Europe. Mutual recognition of academic and professional qualifications.
• Title of European Geologist: Professional quality
• Promote harmonisation of education and training
• Code of professional ethics
• Advice, assistance and collaboration to and between member associations
• Promote a European Geological Policy
• Responsible use of Earth Natural Resources: Energy, mineral, water
• Geological problems in land planning, environmental protection and exploitation of raw materials. Geological Hazards. Geological Engineering.

Then a review of the Spanish plan for the EFG presidency was made. A plan which had the following political objectives for which the following action plans were proposed and carried out:

Objective 1.

To have and influence on the decisions with geological impact (administrative and legal) of the EU.

Last year in Budapest the Council of the EFG appointed a new Board leaded by Gareth Jones, its former Vice-President. This ended a long period (1994-999) in which Spain has had different posts in the Board of the EFG, culminated by the last three years in which I have held the post of EFG President.

Action program

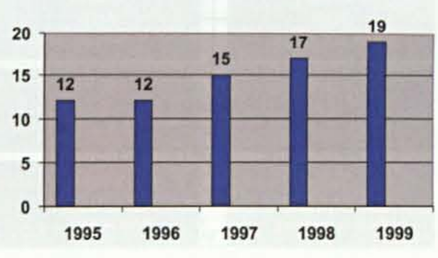
– Compile professional relevant information on the structure of the European legislation, government bodies which are dealing with geological items.
• When and where decisions are being made
• Geological relevant lobby groups
• Name and addresses of geologists that work in European administration and politics.

– Focus reports made by EFG WG on narrow topics to be used in draft directives of the Commission. Target the technicians preparing draft directives for the Commission.

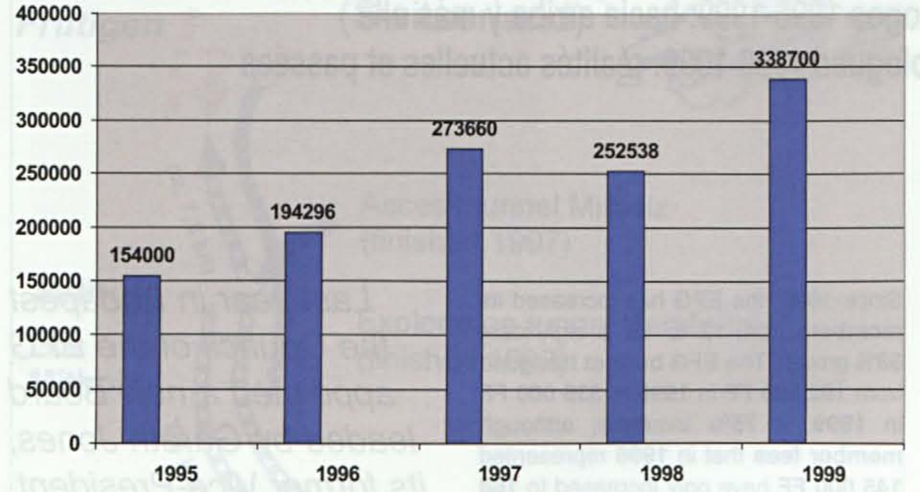
– Working Groups to prepare EFG position papers to be used as quick reference regarding the main geological issues.

– Maintain regular contacts with EU officials and MP's to present the EFG

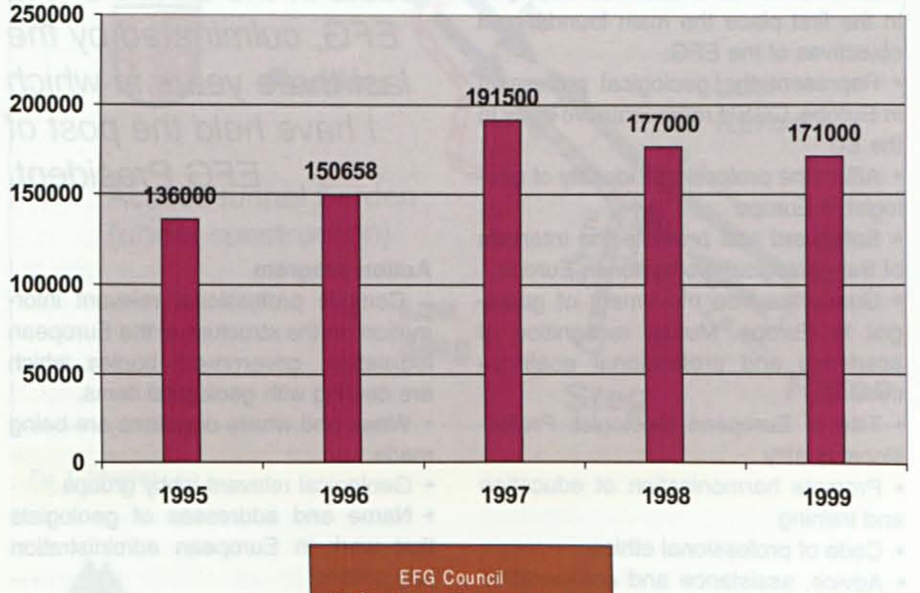
EFG MEMBER COUNTRIES

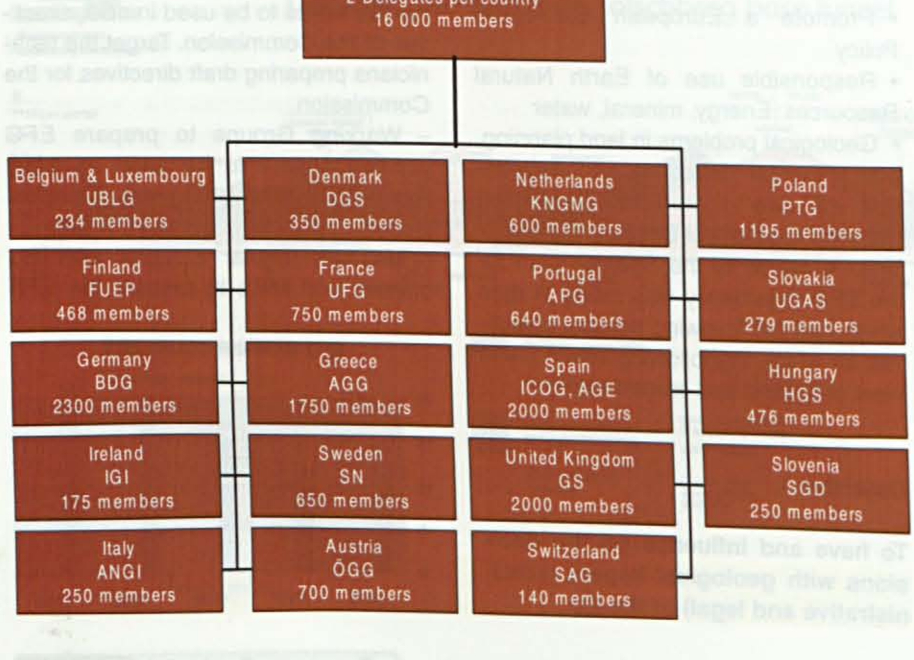


EFG BUDGET FF



EFG MEMBER FEES (FF)





ideas and propose focused solutions to geological related matters.

Objective 2

To favour free movement of geological professionals, and to protect the right to work in any European country of our members.

Action program

– Prepare a Dossier on Education including:

• Level of natural science knowledge in high school (14-18 years old) in the different countries.

• A directory of all possible European centres where the title of geologist can be obtained.

• The denomination of the different titles obtained.

• The subjects studied during the career.

– To feed the Draft Sectorial Directive by DGXV on Diplomas equivalence for Geologist, requesting among other the absence of compensation measures for European Geologists.

– Compel all member Associations to create the Vetting Committee for the Title of European Geologist, with similar statutes and regulations supervised by the Board.

– Give publicity to the Title of European Geologist in all member states as a quality label.

Objective 3

To be known and used as reference and information institution by members Associations and their associated, as well as by the geological and geoscientific European world in general.

Action program

– Continue the publication of the European Geologist magazine with two issues per year.

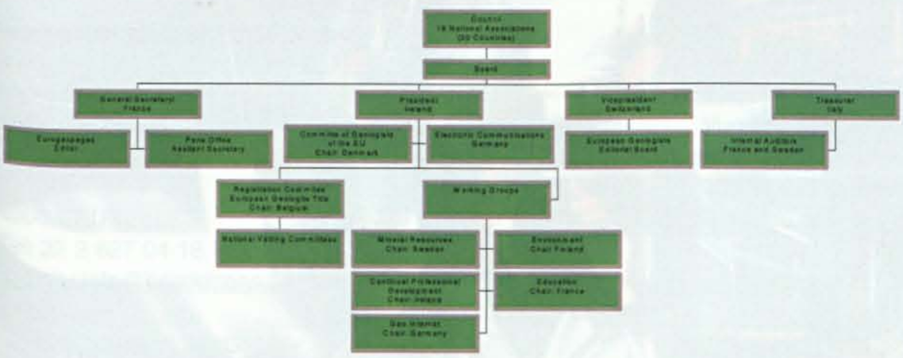
– Continue to produce the Eurogeopages to be included in Internet.

– Produce and maintain a EFG WEB page in Internet through which to distribute all the available information to all member countries and interested parties.

– Centralise all correspondence by e-mail

Objective 4

To get jobs for unemployed geologists all over Europe



Action program

- Implement Eurogeojobs in Internet.
- Establish agreements with organisations and institutions to provide them with geologists.
- Create a database of companies that employ geologists

Objective 5

To enlarge the Federation with new member countries of Europe (eastern and western)

Action program

- The EFG should establish professional networking in all interested associations through personal and fraternal contacts to incorporate new active members for the Federation.

Among EFG achievements from 1980 to 1999 fulfilling the above mentioned foundational objectives and the Spanish plan, its worth mentioning:

- Code of Professional Conduct. 1984
- Dossiers
- Energy in Europe. 1984
- Strategic Minerals. 1985
- Geological Mapping.1985
- Education. Summary of qualifications leading to the title of geologist in EFG member countries. 1987
- Groundwater pollution. 1992
- Environment & Geology. 1996
- Title of European Geologist. Since 1995
- Eurogeopages. Since 1989
- European Geologist Magazine. 1995
- Eurogeojobs. 1996
- Web page. 1997. http://efg.gsf.fi
- Press releases after each Council meeting. 1996-1999
- The American Institute of Professional Geologists as EFG associated member. 1998
- Creation of the NGO World Geologists. 1999
- Co-organisation of the 1st International Professional Geologist Conference. Alicante 2000.
- Presentation of the EFG to the European Parliament and DGXI of the EU Commision. 1999

Follow several tables reflecting current EFG structure, members and statistics in 1999.

The EFG has started a route of unbeatable growth with this last few years. Its last meeting point will be the **1st International Professional Geology Conference** which will be celebrated in Alicante (Spain) next July. The presence of Dr Charles Groat, Director of the US Geological Survey, Dr. Jonathan G. Price, State Geologist and Director of the Nevada Geological Survey, Dr Emilio Custodio, Director of the Spanish Geological Survey, Eng. Luis Costa Rodrigues, Director of the Geological Survey of Portugal and Dr Tadeusz Bachleda-Curus, Chief Geologist of Poland and Richard Annels, General Manager of Eurogeosurveys, in the first event of the Conference, is a clear indication of the tremendous success and expectations this Conference represents for professional geology.

The EFG has a great future, but to convert a promising future in a tangible reality takes time, effort, dedication and money. I encourage the new Board and all EFG members to go ahead and follow the lead and continue on the line established at the same pace and with an ever growing rate.

EFG STATISTICS

Country	Nº geologists		Movement of geologists		Unemployed geologists
	Nº of members of the professional association	Total nº of geologists (est.)	Annual nº of graduates	Nº of jobs	
Austria	700	n.d	n.d	n.d.	n.d
Belgium/Luxembourg	234	1100	40	34	100
Denmark	350	1200	n.d.	n.d.	n.d.
Finland	468	580	45	10	47
France	750	6000	400	300	300
Germany	2200	18000	1000	100	50
Greece	1700	3600	250	100	1700
Hungary	476	1200	n.d.	n.d.	n.d.
Ireland	175	250	60	10	10
Italy	7000	10000	700	350	1500
Netherlands	600	2000	100	50	100
Poland	1195	2000	n.d.	n.d.	n.d.
Portugal	640	1400	100	30	10
Slovakia	279	800	n.d.	n.d.	n.d.
Spain	2000	5500	600	150	400
Switzerland	409	1600	n.d.	n.d.	n.d.
Sweden	650	850	120	30	70
Turkey	6580	10000	n.d.	n.d.	n.d
Norway	1100	2060	130	94	0
Check Republic	761	1961	70	20	0
United Kingdom	2600	10000	1000	300	80
TOTAL	30267	>74 000	> 4615	> 1578	> 4367

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Turbidite Systems of Southeast France. Application to Hydrocarbon Prospectivity

Kevin T. Pickering & Vincent C. Hilton
230 pages with over 130 figures, including many colour figures and plates,photomosaics and 4 pull-outs. (ISBN 0-952731370-6). Published June 8th 1998 PRICE: £50.00 In UK
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This book contains:

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Summary

The Tertiary Grès d'Annot Formation of SE France is a late Eocene-early Oligocene sand-rich deep-marine system deposited in a rectilinear foreland basin created by lithospheric loading of both the Alpine thrust sheets to the east and the Corsica-Sardinia basement to the south. This foreland basin was created by the interference effects of two perpendicular loads on the lithosphere. Palaeocurrents show that the principal source of the voluminous sediment flux to the Grès d'Annot system was from Corsica-Sardinia and southernmost Provençe, with very little sediment supply from the Alpine thrust sheets to the east. By mid Oligocene time, the Corsica-Sardinia crustal blocks, together with the southernmost parts of Provençe had become an active volcanic arc above a N/NW-dipping subduction zone, with back-arc rifting eventually leading to the separation of the Corsica-Sardinia microplate from the Eurasian plate to create the marginal basin, represented today by the Western Mediterranean Basin and the Ligurian Sea, which are floored by oceanic crust. The plate-tectonic change from late Eocene (mainly) crustal compression to mid-Oligocene NNW-SSE directed crustal extension, and the rifting away of the Corsica-Sardinia microplate at the southern side of the Grès d'Annot system, were the cause of the switching off of sediment supply to the foreland basin. Later westward propagation of the Alpine thrust system throughout the Grès d'Annot system caused local intense deformation of parts of the stratigraphy, including the creation of the late Paleogene Schistes-à-bloc which has been thrust over the well-bedded parts of the Grès d'Annot Formation.

Throughout Haute Provençe, late Eocene subsidence created a basin with a complex inherited sea-floor topography compartmentalised into local topographic highs and lows. The topographic lows acted as sites for the preferential accumulation of sediments from sediment gravity flows, mainly turbidity currents, debris flows and slide deposits. Sandstone accumulation was controlled principally by pre-existing basin topography and, only locally, syndepositional extensional faulting. The lack of typical submarine fan features in the Grès d'Annot Formation, the absence of a well-defined point source for sediment supply, and the presence of contemporaneous fan-delta deposits immediately sourcewards of parts of the deep-water deposits, suggest a multiple sourced fluvial feeder system from a possible ramp margin. From a detailed study of the Paleogene turbidite systems in Haute Provençe, we propose a new and integrated depositional model for high-continuity sand-prone deep-marine systems which appears to provide a better analogue than the tripartite fan model for many hydrocarbon reservoirs such as the Neogene northern continental margin of the Gulf of Mexico, Paleogene of the northern and central North Sea, West-of-Shetland, and much of the continental margins off east and west Africa. Geometrical aspects of the Grès d'Annot system are quantified and compared with other deep-water systems.

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In essence, many of the deep-water sand bodies in the Grès d'Annot Formation are characterised by a basin-wide extent (< tens of km) but comprise laterally discontinuous individual beds and thin packets of beds.

Such discrete bundling of sands and gravels into packets typically 10-30 m thick, separated by thick (to 10s m) finer grained intervals, suggests a metronomic switching on-and-off of sand supply. Without a high-resolution stratigraphy for this system it remains impossible to evaluate the relative importance of tectonic uplift/subsidence, eustatic sea-level change and changing rates of sediment supply (flux) in producing the stratigraphy. Despite such limitations, this book provides a detailed examination of a relatively well-exposed deep-water system which should have wide academic and industrial application.

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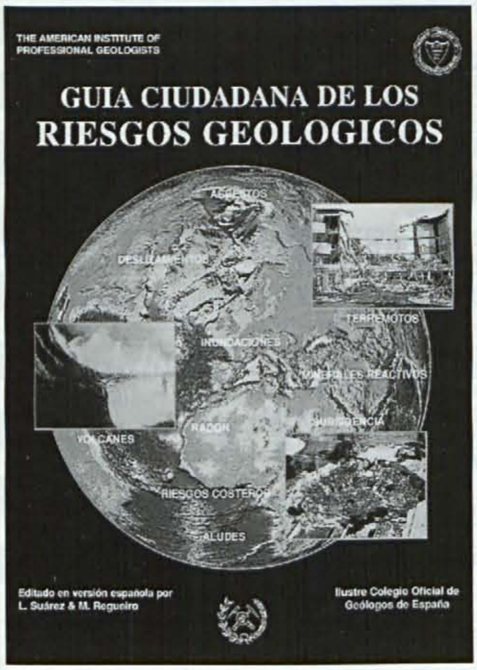

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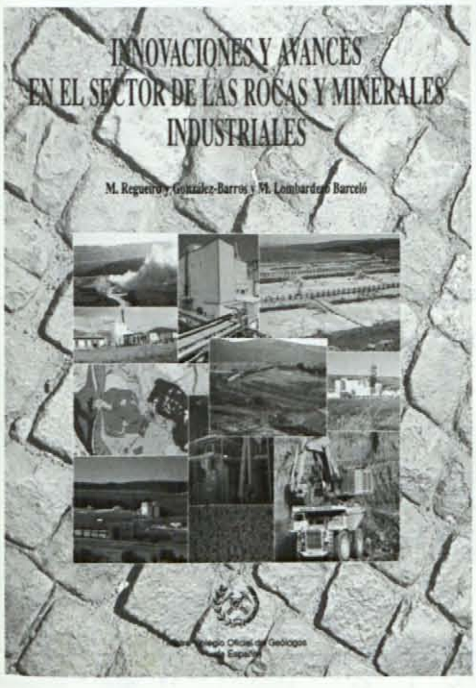

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Tel: +39 055 500 21 74; Fax: +39 055 57 34 25. renewables@tnet.de. http://www.etaflorence.it.

6-7. The Millennium Forests for Life Conference, and Global Trade Fair for Certified Products. Environmental Management. London Arena, Limeharbourg, London.
Tel: 44 1483 419 266; Fax: 44 1483 427 965.
E-mail: wwf-uk-tradefair2000@wwfnet.org.
http://www.panda.org/tradefair2000/tradefr2000.htm.

6-7. ET: Environmental Technology. National Exhibition Centre, Birmingham, United Kingdom. Tel: +44 0 20 8910 7844; Fax: +44 0 20 8910 7989.
E-mail:louise.page@reedexpo.co.uk.
http://www.et-expo.co.uk.

6-7. Groundwater 2000 - International Conference on Groundwater. Copenhagen, Denmark.
Tel: +45 45 85 97 27; Fax: +45 45 83 97 27.
E-mail: gw2000@isva.dtu.dk.
http://www.wlu.ca/~wwwiahs/index.html.

7-8. 5th German Wind Energy Conference. Wilhelmshaven, Germany.
Tel: +49 4421 4808 0; Fax: +49 4421 4808 43. E-mail: dewek2000@dewi.de.
http://www.dewi.de/.

11-18. International Conference on ISO 14000 standards of Environmental Management. Stockholm, Sweden.
Tel: +46 8136 283.
E-mail: kristina.sandberg@stg.se.
http://www.stg.se/stockholm2000/.

13-16. International Town Planning and Environment Week. Parque Ferial Juan Carlos I, Madrid, Spain.
Tel: 34 91 722 53 32; Fax: 34 91 722 58 07.
E-mail: infoifema@ifema.es.
http://www.tecma.ifema.es/indice_i.htm.

13-16. IWM Annual Conference & Exhibition 2000. Paignton, Torquay, United Kingdom.
Tel: + 44 0 1604 620426; Fax: + 44 0 1604 604467.
E-mail: events@iwm.co.uk.
http://www.iwm.co.uk/main.html.

14-16. International Ecological Congress and Exhibition. St.Petersburg, Russia.
Tel: + 7 812 301 86 61; Fax: + 7 812 316 15 59.
E-mail:newecol@spb.cityline.ru.
http://www.newecol.spb.ru/info_eng.htm.

15-18. II International Symposium on Anaerobic Digestion of Solid Waste (II ISAD-SW). Barcelona. Spain.
Tel: + 34 929 920 591; Fax: + 34 919 751 180.
E-mail: congres@waste.qui.ub.es.
http://www.ii-isad-sw.ub.es/.

19-21. Expo 2000 Global Dialogue. Hannover, Germany.
E-mail: arno.rosemarin@sei.se.
http://www.environmental-expert.com/events/expo2000/expo2000t.htm.

19-21. EuroSun 2000. Bella Center, Copenhagen, Denmark.
Tel: +45 73 423100; Fax: +45 73 423101.
E-mail: torben.esb@esbensen.dk.
http://www.eurosun2000.dk.

26-29. New and Renewable technologies for sustainable development. Maderia, Portugal.
Tel: +32 2 3750281.
E-mail: vargyraki@skynet.be.
http://navier.ist.utl.pt/renewables2000.

26-29. Entsorga. Cologne, Germany.
Tel: 0181 681 8166; Fax: 0181 681 8028.
E-mail: entsorga@KoelnMesse.de.
http://www.koelnmesse.de/entsorga/.

26-30. Renewable Energy for the Developing World. Carbondale, Colorado, USA.
Tel: 970 963 8855; Fax: 970 963 8866.
E-mail: sei@solarenergy.org.
http://www.solarenergy.org.

28-30.ENVIROSOFT 2000: Development and Application of Computer. Techniques to Environmental Studies. Bilbao, Spain. Tel: 44 0 23 80 293223; Fax: 44 0 23 80 292853.
E-mail:ksavage@wessex.ac.uk.http://www.wessex.ac.uk/conferences/2000/envsoft2000/.

29-30. Eco-management and Auditing Conference. University of Manchester, Manchester, United Kingdom. Tel: +44 01274 530 408; Fax: +4401274 530 409.
E-mail: elaine@erpenv.demon.co.uk.
http://www.erpenvironment.org.

July 2000

1-7. WREC 2000 (The Energy for The 21st Century). Brighton, United Kingdom.
Tel: +44 0 118 961 1364; Fax: +44 0 118 961 1365.
E-mail: asayigh@netcumuk.co.uk.

2-4. Renewable Energy 2000. Brighton Metropole Hotel, Brighton, United Kingdom.
Tel: +44 181 910 7878; Fax +44 181 910 7813. E-mail: rob.schulp@reedexpo.co.uk.
http://www.reedexpo.com.

2-4. Conference on Contaminants in Freezing Ground. Fitzwilliam College, Cambridge, United Kindom.
Tel: +1 613 260 3164.
E-mail: conferencesecretariat@freezingground.org.
http://www.freezingground.org/conf2000.

3-6. 2000 and Beyond: Which Choices for Waste Management?. Paris, France.
Tel: +33 1 5370 1351; Fax: +33 1 5370 1340.
E-mail: aghtm@aghtm.org.
http://www.aghtm.org.

3-6. REDI 2000: Renewable Energy for Developing Infrastructure. Loughborough University, Leicestershire, United Kingdom.
Tel: +44 0 1509 223466; Fax: +44 0 1509 610031.
E-mail: A.J.White1@Lboro.ac.uk.
http://www.lboro.ac.uk/crest/redi2000.html.

3-7. New Trends in Water And Environmental Engineering for Safety and Life: Eco-compatible Solutions for Aquatic Environments. Island of Capri, Capri, Italy.
Tel: +39 02 23996293; Fax: +39 02 23996298. E-mail: terra@marina.iar.polimi.it.

3-7. 1st World Congress of the International Water Association. Paris, France.
Tel: +33 1 53 70 13 51; Fax: +33 1 53 70 13 40. E-mail: aghtm@aghtm.org.
http://www.iawq.org.uk/paris2000/paris.htm.

5-7. Energy Saving Conference. ECOS 2000. Europe, Enschede, The Netherlands University of Twente Enschede, The Netherlands.
Tel: +31 53 4892530; Fax: +31 53 4893663.
E-mail: g.g.hirs@wb.utwente.nl.
Web: http://www.ecos2000.nl/.

7-8. Intersolar 2000: Trade Fair and Conference for Solar Technology. New Exhibition Site, Freiburg, Germany.
Tel: +49 7231 351380; Fax: +49 7231 351381. E-mail: info@intersolar.de.
http://www.intersolar.de.

10-14. 1st International Conference of Professional Geology. Alicante. Spain. Organising Committee: Spanish Association of Geologists (ICOG). Reina Victoria, 8, 28003 Madrid. Spain.
Tel: 34 915532403 Fax: 34 915330343.
E-mail: Icog@icog.es. European Federation of Geologists (EFG). Rue Claude-Bernard 75005. Paris. France. Tel: 33 1 47079195 Fax:33 1 47079193. E-mail: efgparis@hol.fr.

10-14. Spanish National Geological Congress. Alicante. Spain. Spanish Geological Society. Departamento de Ciencias de la Tierra y Medio Ambiente. Facultad de Ciencias. Campus de San Vicente del Raspeig. Universidad de Alicante. Apt. 99. 03080 Alicante. Spain. Dr Salvador Ordoñez Chairman.
Tel: 34 965903552 Fax: 34 965903552.
E-mail: Salvador@ua.es.

11-15. APC-2000 Australian Palaeontological Convention. Orange NSW. For details: Mr George Wilson, Department of Earth and Planetary Sciences, Macquarie University, Sydney NSW 2109.
Web www.es.mq.edu.au/MUCEP/auscos/auscos.htm. (TAG111, p.36)

16-21. Sustainable use of water: quality and quantity. Guildford, UK.
Tel: +44 0 1865 316636; Fax: +44 0 1865 557368.
E-mail: network.events@britishcouncil.org.

23-28. XXI International Mineral Processing Congress, Rome Italy. XXI IMPC Organising Committee, c/o Dipartimento di Ingegneria Chimica, dei Materialli, delle Materie Prime e Metallurgia, PO Box 5077, 00153 Roma Ostiense, Italy.
Tel: 39 6 44585891 Fax: 39 6 44585891.
E-mail:impc2000@imagemp.ing.uinromal.it.

August 2000

14-16.10th Stockholm Water Symposium. Stockholm, Sweden.
Tel: +46 8 522 139 75; Fax: +46 8 522 139 61. E-mail: sympos@siwi.org.
http://www.siwi.org/sws2000/sws2000.html.

Aug. 28-Sep. 1. 8th International Conference on Thermal Energy Storage (Terrastock 2000). Stuttgart, Germany.
Tel: +49 711 685 3536; Fax: +49 711 685 3503. E-mail: terrastock@itw.uni-stuttgart.de.
http://www.itw.uni-stuttgart.de/terrastock.

Aug. 31-Sep. 1. European Energy Saving Conference 2000 - Towards an Integrated European Energy Market. Europe Bergen, Norway.
Tel: +47 55 959 500; Fax: +47 55 959 439.
E-mail: annekristin.wilhelmsen@snf.no.
Web: http://www.snf.no/.

Dates to be advised. 31st International Geological Congress, Río de Janeiro, Brazil. Secretariat Bureau, Av. Pasteur 404 – Anexo 31 IGC, Urca, Rio de Janeiro, RJ – CEP 22.290-240, Brazil. Tel: 55 21 2955847 Fax: 55 21 295 8094.
E-mail: 31igc@31igc.org.br
Web: www.31igc.org.br.

September 2000

6. International Conference on On-line Sensors for Water and Wastewater Treatment. Cranfield University, Bedfordshire, United Kingdom.
Tel: 01234 754041.
r.stuetz@cranfield.ac.uk. http://www.cranfield.ac.uk/sims/water/sensors.htm.

1-5. EXPO 2000 Symposium: Efficiency through Management of Resources: Green Productivity Programs in SME's. Hannover/ Magdeburg, Germany.
Tel: +49 391 671 8848; Fax: +49 391 671 2644. E-mail: EXPO@iff.fhg.de.
http://expo-foe.iff.fhg.de/.

6-7. British Wind Energy Association Conference 22. Durham, United Kingdom.
Tel: +44 0 20 7402 7102; Fax: +44 0 20 7402 7107.
http://www.bwea.com.

11-12. European Environment Conference. London School of Economics, London, United Kingdom.
Tel: +44 01274 530 408; Fax: +44 01274 530 409.
E-mail: elaine@erpenv.demon.co.uk.
http://www.erpenvironment.org.

11-12. Water Supply and Water Quality. Krakow, Poland.
E-mail: oleszkie@cc.umanitoba.ca.
http://www.akkc.dk/environment.

11-13. IVth International Conference - Water Supply and Water Quality. Krakow, Poland.
E-mail: office@lemprojekt.com.pl.
http://www.lemprojekt.com.pl/water2000.

11-13. Minprex 2000, Melbourne, Australia. Australian Institute of Mining and Metallurgy, PO Box 660 Carlton South, Victoria 3053, Australia. Tel: 61 3 96623166 Fax: 61 3 96623662.
E-mail: conference@ausimm.com.au.
Web: www.ausimm.com.au.

11-14. Dissolved Air Flotation Conference in Water and Wastewater Treatment. Marina Congress Center, Helsinki, Finland.
Tel: +358 50 3380603; Fax: +358 9 1484750.
E-mail: daf@vvy.fi. http://www.vvy.fi/daf/.

11-14. International Hydrogen Energy Forum 2000 (HYFORUM 2000). München (Munich), Bayern, Germany.
Tel: +49 228 959 560; Fax: +49 228 959 5650. E-mail: energie.forum@t-online.de.
http://www.zukunftsenergien.de.

11-15. Electra Mining Africa 2000, Johannesburb, South Africa. John Kaplan, Director Specialised Exhibition, PO Box 2900, Johannesburg 2000, South Africa.
Tel: (+27 11 11)8351565 Fax: 4961161.

12-14. Fifth International Symposium and Exhibition on Environmental Contamination in Central and Eastern Europe. Prague, Czech Republic.
Tel: 850 644 7211; Fax: 850 574 6704. E-mail: Prague2000@mailer.fsu.edu.
http://www.prague2000.fsu.edu/.

12-14. Recycling & Waste Management Exhibition. NEC, Birmingham, United Kingdom. Tel: +44 020 8277 5540; Fax: +44 020 8277 5560.
E-mail: steved@maclaren.emap.co.uk.

14-15. Business strategy and the environment. London School of Economics, London, United Kingdom.
Tel: +44 01274 530 408; Fax: +44 01274 530 409.
E-mail: elaine@erpenv.demon.co.uk.
http://www.erpenvironment.org.

18-19. Business Strategy and the Environment Conference. Devonshire Hall, University of Leeds, United Kingdom.
E-mail: elainewhite@erpenvironment.org.
http://www.erpenvironment.org/cfrence/bse.htm.

18-19. VI Geomorfological Meeting. Universidad Complutense de Madrid, Facultad de Ciencias Geológicas. Departamento de Geodinámica. 28040 Madrid, Spain.
Tel: 34 913944890 Fax: 34913944845.
E-mail: Alfredog@eucmax.sim.ucm.es.

18-19. WATERMATEX 2000 - Systems Analysis and Computing in Water Quality. Gent, Belgium. E-mail: Philippe.Geril@rug.ac.be.
http://hobbes.rug.ac.be/WATERMATEX2000/.

19-21. IV Tertiary Conference. Tremp. Lleida. Spain. Tels: +34 935811085 & +34 935811603.
Fax: +34 935811263.
E-mail: iget@cc.uab.es & Eudald.Maestro@uab.es.
www.catalunya.net/gettremp2000.

20-22. Oil Spill 2000: 2nd International Conference on Oil & Hydrocarbon Spills, Modelling, Analysis & Control. Las Palmas de Gran Canaria, Spain.
Tel: 44 0 2380 293223; Fax: 44 0 2380 292853. E-mail: wit@wessex.ac.uk.

20-22. International Exhibition and Conference on Energy and Power. Europe Zaragoza, Spain. Tel: 976 76 47 00; Fax: 976 33 06 49.
E-mail: info@feriazaragoza.com.
Web:http://www.feriazaragoza.com/powerexpo/uk/powerinduk.htm.

25-27. Wind Power for the 21st Century. Kassel, Germany.
Tel: +49 8 9720 1235; Fax: +49 8 9720 1291.
E-mail: info@wip-munich.de.
http://www.wip.tnet.de.

25-27. Monitoring Tailor-made III. Nunspeet, The Netherlands.
Tel: +31 24 323 44 71; Fax: +31 24 360 11 59. E-mail: regmtm.III@congres.net.
http://www.minvenw.nl/rws/riza/bcm/riza.html.

26-29. Conference on Wastewater and EU-Nutrient Guidelines. Amsterdam, The Netherlands.
Tel: +31 20 46 02 466; Fax: +31 20 46 02 475.
E-mail: r.r.kruize@inter.nl.net.
http://www.nva.net/aquatech2000/welcome.html.

26-29. International Trade Event of Water Technology and Water Management. RAI Exhibition Center in Amsterdam, The Netherlands.
Tel: +31 020 549 12 12; Fax: +31 020 549 18 93.
E-mail: aquatech@rai.nl.
http://www.aquatech-rai.com.

October 2000

1-4. Agricultural Effects on Ground and Surface Waters: Research and Policy. Wageningen, The Netherlands.
Tel: 0031 0 317 474700; Fax: 0031 0 317 419000.
E-mail: j.h.a.m.steenvoorden@alterra.wag-ur.nl.
http://www.alterra.wageningen-ur.nl.

2-4. HYDRO 2000 Conference and Exhibition. Europe Bern, Switzerland.
Phone/Fax:+44 20 8643 8200.
E-mail: conf@hydropower.cix.co.uk. Web:
http://www.hydropower-dams.com/hydro2000/.

3-6. Membranes in Drinking and Industrial Water Production. Paris, France. Tel: +33 1 3480 2378; Fax: +33 1 3053 6207.
E-mail:jmlaine@cirsee.suez-lyonnaise-eaux.fr.

5. Flood Warning and Management: Seeking the questions for the new millennium. London, England.
Tel: 44 1787 248097; Fax: 44 1787 248267.
E-mail : erica@lavenhamgroup.co.uk.

5-6. Water Environment 2000: Flood Warning & Management. Westminster, London, United Kindom.
Tel: +44 1787 249290.
E-mail: erica@lavenhamgroup.co.uk.

7-12. Natural Waters and Water Technology. Albufeira, Portugal.
Tel: +33 388 76 71 35; Fax: +33 388 36 69 87. E-mail: euresco@esf.org.
http://www.esf.org/euresco.

9-12. MinExpo International 2000. Las Vegas, Nevada, US. Contact National Mining Association, Manufacturers and Services Division.
Tel: +1 202 463-2607. Fax: -9799.

10-12. Powers 2000. The Energy Fair. Messegelände Düsseldorf, Düsseldorf, Germany.
Tel: +49 0 211 4560 01; Fax: +49 0 211 4560 668.
E-mail: info@messe-duesseldorf.de.
http://www.messe-duesseldorf.de.

11-13. US/European Environmental Business Partnering Event: Environmental Technologies for the Third Millennium (ET3M). Vienna, Austria.
Tel: 202 408 6838.
David S. Smith@ceq.eop.gov.

11-15. 37th Annual AIPG National Meeting, Milwaukee, Wisconsin.

17-19. Energy and EnerNet 2000 Trade Fair. Tampere Fair Centre Pirkkahalli, Tampere, Finland.
E-mail: pekka.tiusanen@finergy.fi.
http://www.energia.fi/finergy/.

17-19. EEBW 2000 - Energy Efficiency Business Week. 6th International Conference and Exhibition. Prague, Czech Republic.
Phone/Fax: +42 2 24247597.
E-mail: seven@svn.cz. http://www.svn.cz.

18-19. Euro Environment 2000. Aalborg, Denmark.
Tel: +45 9935 5555; Fax: +45 9935 5580.
E-mail: steffen thomsen@akkc.dk.
http://www.environmental-expert.com/events/ee2000/ee2000.htm.

November 2000

13-24. 6th Conference of the Parties to the United Nations Framework Convention on Climate Change. The Hague, the Netherlands. Tel: +49 228 815 1000; Fax: +49 228 815 1999. E-mail: secretariat@unfccc.de.
http://www.unfccc.de/.

February 2001

26-28. SME Annual Meeting & Exhibit, Denver, US. Society for Mining, Metallurgy and Exploration, PO Box 625002, Littleton, CO 80162-5002, US.
Tel: (+1 303) 9739550. Fax: 979 3461.
E-mail: smenet@aol.com.

March 2001

11-14. Prospectors & Developers Association of Canada Annual Convention, Toronto. PDAC, Suite 900, 24 King Street E., Toronto, Ontario, Canada M5C 2X8.
Tel (+1 416) 3621969. Fax: 3620101.
E-mail: hsklarz@pdac.ca.

April 2001

2-8. Bauma 2001. The World's largests construction exhibition to be held at Messe Munchen, Germany.
Tel: +49 89-51070. Fax: -5107506.
Web: www.bauma.de.

4-6. Advances in Rapid Granular Filtration in water/ww Treatment. Imperial College, London, UK.
Tel: +44 1787 249290.
E-mail: erica@lavenhamgroup.co.uk.

23-28. Hannover Fair 2001. Hannover, Lower Saxony, Germany.
Tel: +49 8151 99 89 32.
E-mail: arno@fair-pr.com.
http://www.fair-pr.com.

June 2001

5-6. The First IWA Conference on ICA and Sensors (Wastewater Treatment). Malmö, Sweden.
Tel: +46 46 222 4788; Fax: +46 46 142114.
E-mail: ICA2001@iea.lth.se.

27-29. COGS Marine Geology Conference, Antartic CRC, University of Tasmania, Hobart. For details: COGS web page:
www.antcrc.utas.edu.au/cogs.
Chairperson Peter Harris, Paleo-Environment Program, Antartic CRC and AGSO. GPO Box 252-80, Hobart, Tasmania 7001.
Tel: (03)62262504. Fax: (03) 62262973.
E-mail: P.Harris@utas.edu.au.

October 2001

16-18. FILTECH EUROPA 2001- International Conference and Exhibition. Congress Center Düsseldorf, Stockumer Kirchstr. 64, Düsseldorf, North Rhine Westphalia, Germany.
Tel: +49 0 211 6411879; Fax: +49 0 211 6411912.
E-mail: info@FiltechExhibitions.de.
http://www.filtechexhibitions.de/.

24-25. LARAC Conference (The annual Local Authority Recycling Advisory Committee Conference). BIC, Bournemouth, United Kingdom.
Tel: +44 020 8277 5540; Fax: +44 020 8277 5560.
E-mail: fraserm@maclaren.emap.co.uk.

24-25. Water Management for the 21st Century - Learning from 20th Century Experience. Berlin, Germany.
Tel: +44 20 7654 5500; Fax: +44 20 7654 5555. E-mail: elaine.robertson@iwahq.org.uk.

March 2002

10-13. Prospectors & Developers Association of Canada Annual Convention, Toronto. PDAC, Suite 900, 24 King Street E., Toronto, Ontario, Canada M5C 2X8.
Tel (+1 416) 3621969. Fax: 3620101.
E-mail: hsklarz@pdac.ca.

11-13. SME Annual Meeting & Exhibit, Phoenix, US. Society for Mining, Metallurgy and Exploration, PO Box 625002, Littleton, CO 80162-5002, US.
Tel: (+1 303) 9739550. Fax: 979 3461.
E-mail: smenet@aol.com.

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The EFG needs quality articles for future issues of European Geologists. EFG members and readers are encouraged to submit articles or contact the Editor to recommend individuals who should be asked to submit articles. Submissions should be 1000 to 2000 words in length, although longer texts could be accepted. A brief abstract should be included in English, French and in the language of the article. Articles submitted on diskette along with a hard copy are appreciated. The Editor uses Word 6, Word 7, WP for Windows 95, or Mac files, both preferably in 3,5 diskettes. Photographs, figures, tables, etc are welcome. Photographs enhance articles and make great EG covers. Be sure to send photographs when possible with your article, or send your favorite photograph for considerations for a future EG issue. Submission deadline is 4 weeks preceding month of issue. 1st May for June issue and 1st November for December issue.

Photographs or graphics should be sent uncompressed in optical disk, removable disk or zip (100 Megabyle) disk when in computer format. Alternatively slides or paper copies are also welcomed.

Acceptable languages will be Spanish, English and French, although for the sake of uniformity it would be desirable to have them in English. Several methods of submitting reports and articles are available. Listed below in order of preference, are the methods of submitting materials to the European Geologist magazine.

1.–Send files via e-mail to m.regueiro@itge.mma.es and follow with a fax to 34-91-4426216 for confirmation of the text.

2.–Send an IBM or MAC compatible computer disc (3,5") in Word 6, Word 7, Wp, RFT with a printout.

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  - Hydrogeology

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EUROPEAN FEDERATION OF GEOLOGISTS (EFG)

The representatives of the British, Spanish, French and Italian National Associations of Geologists met in London in 1978 in order to establish the European Federation of Geologists and outline its Statutes, the final text being drafted during the meetings that took place in Paris and Madrid in the months of March and November 1979, Belgian and Irish geologists attended those meetings as observers.

The E.F.G. was officially horn in Paris en 1980 during the 26th International Congress of Geology, and was composed of Professional Associations from Spain (A.G.E.-I.C.O.G.); Italy (A.N.G.I.-O.N.G.); Portugal (A.P.G.); United Kingdon (I.G. now incorporated in the G.S.); France (U.F.G.); Belgium and Luxembourg (U.B.L.G.) In July of the same year the Statutes were presented to the European Economic Community in Brusels.

The geologists of the Federal Republic of Germany (B.D.G.) became members of the F.E.G. in 1985, Ireland (I.A.E.G.) in 1988, Finland (F.U.G. now F.U.E.P.) and Sweden (S.N.) in 1989, Greece (A.G.G.), The Netherlands (K.N.G.M.G.) in 1993, Poland (P.T.G.), Denmark (D.F.G.) and Slovakia (S.A.E.G.) joined the E.F.G. in 1997.

The E.F.G. currently represents some 65.000 geologists from 17 countries.

OBJECTIVES OF THE E.F.G.

1. To represent the geological profession in Europe. The Committee of Geologists of the European Community (C.G.E.C.) of the E.F.G. is the organization authorized to make representation to the European Union and its various bodies.
2. To safeguard and promote the present and future interests of the geological profession in Europe, including:
   - To guarantee the free movement of geologist in Europe, with the mutual recognition of their academic and professional qualifications by the adoption of the title of European Geologist.
   - To promote the harmonisation of education and training.
   - To define and protect the title of geologist and related professional titles.
   - To promote the code of professional ethics of the E.F.G.
   - To provide advice and assistance to constituent members National Associations.
3. To promote a European geological policy with regard to the responsible use of the Earth's Natural Resources and in particular:
   - Energy Resources.
   - Mineral Resources.
   - Hydrogeological Resources and their pollution problems.
   - Geological problems in land development, environmental protection and the exploitation of raw materials.