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GEOLOGY AND INFORMATICS

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GIBS stands for the Geological Information System for the Belgian Geological Survey.
We will concentrate on the geological aspects to formulate some requirements for GIBS.

Until 1950 the Archives, publications and the geological map were the only sources to get geological information. Since 1950 geology appealed to a lot of other domains like physics, chemistry, electricity, water, . . . to explain a geological phenomena. This evolution involved a lot of data which couldn't anymore be integrated in the existing Archives system. So there is need for a good management system which integrates all those kind of data.

The organization of the Archives is based on geographical localization, which is indeed an important access-criterium. But also other questions like «I only want recent descriptions», or «I'm not interested in the opinion of a certain author» should get a quick answer.

Making an interpretation like a profile on the computer has many advantages: coloring and adapting colors is no problem, extracting only one aspect or a certain detail is quite easy, and limits can be adapted as well on the whole profile as on an extract. All those drawing-facilities can be performed in a minimum of time.

Until now geologists usually visualized their ideas of the underground in 1 or 2 dimensions because it demands a lot of drawing-experience and time to do this in 3 dimensions. With the quick evolutions of CAD (Computer Aided Design) this will change: explaining a wedge-out of a certain layer is much easier on a 3-dimensional model than on different sections. So geologists will be able to visualize their ideas immediately in 3 dimensions instead of working with sections and building up the model in their imagination.

Modeling and simulations to test the ideas of the underground will be often used tools; in the domain of water these facilities are already common on the Belgian Geological Survey.
Again, building models and evaluating simulations would be much more spectacular in 3 dimensions.

The Belgian Geological Survey tried to use the DASCH-system, but with no real success.
DASCH is based on the principle of formatted data: all descriptions of layers have to be in the terminology of an official accepted list. Although, the actual Archives contain no descriptions or interpretations in a formatted form. To achieve this goal the BGS started the following process:

all archivesnumbers will be scanned and treated with OCR-techniques (Optical Character Recognition) to get textual the same content available, in GIBS as in the existing Archives;

by this all subtleties which would be lost if only formatted data were accepted will be available for future users.

For an efficient selection-process, formatted data are necessary. The user will be able to enter those to the system. To do this he could get help of Artificial Intelligence.

GEOLOGICAL RECONNAISSANCE IN THE SUBSURFACE OF THE NORTH BELGIUM : RECENT RESULTS BY THE BELGIAN GEOLOGICAL SURVEY

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Recent investigations by the BGS in cored boreholes revealed remarkable new insights in the paleogeography of the prospected sequences. Two boreholes are described in a different structural and stratigraphic setting: the Molenbeersel well (BGS geol. archive nr. 49W226) in the Rur Valley Graben north of the Campine Basin, and the Wervik K12 well (BGS geol. archive nr. 96W81) at the presumed western extension of the Namur Synclinorium south of the Brabant Massif. Both wells were drilled for geological reconnaissance by the BGS and the Flemish Water Distribution company (VMW) respectively, and cored in wireline PQ in the studied sections.

Molenbeersel

The carbonate succession (1223-1283 m) can be split up into two megasequences, corresponding to the Maastrichtian and the Paleocene. The onset of the Cretaceous transgression thus is much younger than in the adjoining area outside the graben.
The lower megasequence is mainly composed by bioclastic wackestones and biopeloidal packstones. A decrease in glauconite/detrital quartz content, in bioturbation and in the

presence of clay/organic rich interlayers towards younger strata is present. The top (1256,65 m) is characterised by an erosive contact.
These strata reflect deposition in an open marine subtidal environment.

The upper megasequence starts with bioturbated bioclastic packstones/grainstones. Several porous and karstified horizons occur. Subsequently homogeneous, bioclastic grainstones are present, typically composed by a hash of open marine bioclasts and reworked crustose coralline algae fragments. At the top of the sequence algal bindstones occur; they are intercalated within pseudonodular crystalline chalk with bituminous interlayers and pore fillings. This succession reflects deposition in an open marine subtidal setting with a shallowing upward trend.
The two megasequences yield different cementation histories. These are much more complex than the diagenetic evolution affecting the paleocene-cretaceous sequence on the Brabant platform and Campine basin. Early cementation occurred in a marine setting, while late dissolution and cementation relates to a meteoric realm. An early dissolution stage affected most of the aragonitic components and created a network of small dissolution channels. However, these pores are occluded in a later stage by blocky calcite. According to the stable isotope data cementation by the blocky calcite occurred at shallow depth. The present porosity distribution relates mainly to a late dissolution stage and the creation of secondary porosity. Dissolution agents were meteoric water and carbocylic acids liberated near organic rich interlayers.
These results confirm the depositional basin model and the inversion tectonics structure developed by Martin Bless and his school (Bless, Felder & Meessen, 1987).

Wervik

The Upper Devonian traversed in the Wervik K12 borehole is mainly composed of Frasnian dolostones (interval 207-228m) and Famennian fine grained sandstones to siltstones (interval 178-207 m). The cementation and mineralisation history of these units is very complex but the most peculiar feature is the presence of exotic allochems and oolithes in the basal Famennian beds.

These isotropic pale brown spherical or irregularly corroded allochems with microlithic textures and similarly isotropic spastolithic or crushed «oolithes» are probably derived from a vesicular basic volcanic glass affected by submarine alteration (halmyrolysis).
Some vesicles are empty («spherical bubble shards»). They were compressed after transport and burial. Other vesicles are filled to form amygdales. These «oolithes» underwent a devitrification and chloritisation after transport. This discovery could shed a new light on the origin of the oolithic ironstones of the Famennian in Belgium. Indeed conodonts recovered from the 206,97 m level can be assigned to the Middle-Upper *Palmatolepis triangularis* Zone. This can be correlated to the first horizon of oolithic ironstones of Lower Famennian age in the Synclinoria of Namur, Verviers and Dinant (Dreesen, 1982). A transformation from volcanic «oolithes» into chloritic oolithes present in these ironstones seems plausible.

Petrographic analysis indicates a palagonitisation of strongly vesicular volcanic glass («gel-palagonite»), which implies a synsedimentary submarine volcanic activity with high gas pressure. This should have occurred on the Brabant Massif close to the Ashgill volcanic arch, and confirms the important epeirogenic movement and fracturation affecting the Brabant Massif during Middle and Upper Devonian times.

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SEAM DEVELOPMENT AND VITRINITE REFLECTANCE

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The degree of coalification of organic matter has since long been expressed in units of vitrinite reflectance (% Rm). It has been demonstrated that % Rm depends strongly on the thermal history of the organic matter. % Rm data from the Carboniferous in the Netherlands show that the observed coalification trends cannot be explained by geothermal modelling alone. Deviations from the expected downward coalification trends in boreholes have been observed in whole seam samples as well as in subsamples from coal seams.

The deviations can be explained either by postulating differences in the composition of the tanatacoenosis derived from the original peat-swamp environment, or by differences in the degree and process of biochemical degradation following the deposition of organic matter.

There is evidence that especially the postdepositional degradation - being responsible for the selective elimination of organic matter and the constitution of vitrinite precursors - may influence the ultimate vitrinite reflectance values.

It is suggested that the redox-potential of the ambient watermass, which in turn controls the microbiological activity after deposition, may influence the chemical composition of the organic matter and hence the optical properties, i.e. the vitrinite reflectance as well.

ZONED CALCITE CEMENTS : THEIR OCCURRENCE AND INFLUENCE ON THE Mn/Fe RATIO OF VISEAN LIMESTONES OF THE CAMPINE-BRABANT BASIN, BELGIUM

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The Visean limestones of the Campine-Brabant Basin, north of the London-Brabant Massif (Belgium) are characterized by zoned calcite cements which formed early in the diagenesis. Primary occlusion of the pores took place in an oxidizing marine environment and later in meteoric and/or marine pore waters under slightly reducing and shallow burial conditions.

Voluminous isopachous and radiaxial fibrous calcites and bladed cements precipitated in a marine oxidizing environment. Further growth of the bladed calcites occurred under more reducing conditions, as demonstrated by the higher

manganese content and the cathodoluminescence characteristics. The same evolution in the redox potential has been observed in spired syntaxial overgrowths. Intense zonations under cathodoluminescence are present in some syntaxial overgrowths, in rhombohedral calcites and in scalenohedral and blocky calcites.

The analyses of the bulk limestones containing the zoned calcite cements show a high Mn/Fe ratio. This is due to the presence of relatively voluminous zoned cements, which precipitated under slightly reducing (meteoric ?) conditions. The presence of clays and iron oxides in the carbonate rocks lowers the Mn/Fe ratio. Calcites in late diagenetic fractures have a low Mn/Fe ratio.

The Mn/Fe ratio of bulk samples can thus contribute to unravel the diagenetic history of limestones.

TERRESTRIAL SEDIMENTS AND PALEOSOILS FROM THE LOWER DEVONIAN (EMSIAN) IN THE RHENISH MASSIF (W. GERMANY)

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U. Jux (1983) mapped the Upper Bensberger sequence (Emsian) in the Oberbergisches Land (W. Germany) as composed of marginal marine sediments. The present work shows the development of a cyclic set of «fining upwards»-sequences with paleosoils which are overlaid by pyroclastics of the «Hauptkeratophyr (K4)».

The sedimentological parameters of current energy, sedimentation mode, water level, incomplete sedimentation, several paleosoils and the fossil record all point to terrestrial sedimentation.

Within the paleosoils, two types of soils could be distinguished :

1. Hydromorphic soils (sensu Remy, 1980). The groundwatertable remains longer almost at the same level as the soil surface. Increasing insolation forms mud cracks when the groundwatertable falls. According to Remy (1980), they are allochthonous soils, formed seasonally after floods.
   Typical plant communities are *Sciadophyton* sp., *Taeniocrada*-like plants, algae and rare Zosterophylaceae.
   A special root-system is found only in this soil-type.
2. Brown-yellow muddy-silty soil including many roots are rich in concretions of ironhydroxide and terrestrial invertebrate burrows.
   Typical fossils are roots, rhizoms, Zosterophylaceae *(Anisophyton gothani), Drepanophycus, Prototaxites,* algae and carbonised plant fragments (*Pachytheca* and *Prototaxites* fragments).

The Bensberger layers are overlaid by the «Hauptkeratophyr»-ignimbrites. Because of the sedimentological parameters and the laterally marine facies development (in the north and northwest), the depositional environment must have been a lowland at sea-level.

On the basis of the measurements of paleocurrents, it is apparent that the depositional environment lay to the south of the Old Red Continent.

RECENT INVESTIGATIONS OF Pb-Zn MINERALIZATIONS IN SOUTH LIMBURG (NL) AND THE NORTHERN EIFEL

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On the eastern border of the Brabant Massif vein-type Lead-Zinc mineralizations occur in lower carboniferous host rocks of South Limburg. They look very much like the mineralization type of Aachen/Stolberg. Investigations are carried out on drillcores from Valkenburg (Thermae 2002), which consists of paleozoic shales and silicified carbonate host rocks with several occurrences of pyrite, marcasite, sphalerite («Schalenblende»), wurzite, calcite and galena (Friedrich *et al.,* 1987). First microthermometric data show an average homogeneisation temperature (Th) of 125°C. Melting temperatures of last ice (Tm) are about -17°C and eutectic temperatures (Te) are ranging between -52 and -45°C. These data from cogenetic quartz indicate an ascendent transport of the H_2O, NaCl and $CaCl_2$ containing fluids.

In the Aachen/Stolberg Pb-Zn-district some fluid inclusions are measured on cogenetic calcites of drillcores from the Albertsgrube orebody near Stolberg. There are two clusters of homogenisation temperatures with an average of 72°C eg. 157°C. The average melting-temperature of last ice (Tm) amounts to -4°C in the first group and -20°C in the second group. These results point towards a mixing of warmer ascendent fluids with cooler descendent fluids.

Pb-isotopes from both occurrences show a similar distribution and plot into the field, for which Krahn (1988) proposed a postvariscan age. Remobilization from variscan mineralizations is rejected whereas a mobilization of the metals from underlying rocks is expected.

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GIVETIAN-FRASNIAN PHYTOGEOGRAPHY OF EURAMERICA AND WESTERN GONDWANA BASED ON MIOSPORE DISTRIBUTION

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The Givetian and Frasnian phytogeography of Western Gondwana and Southern Euramerica, as interpreted from miospore distribution, shows a rather uniform vegetation prevailing from palaeo-polar to palaeo-tropical regions. Similar climatic conditions are certainly required to explain this but it is concluded from a discussion on the dispersal of homosporous vegetation that a wide ocean separating these regions would have prevented it. Frasnian Northern Euramerica vegetation seems different and might correspond to an equatorial belt.

Heckel & Witzke's paleogeographical reconstruction fits much better with the miospore distribution than other maps.

COMPARISON OF CARBONATE TYPES FROM THE LOWER/MIDDLE DEVONIAN BOUNDARY BEDS OF THE SOUTHERN EIFEL HILLS AND THE DINANT SYNCLINE

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Detailed studies on carbonate microfacies of the Lower/Middle Devonian boundary beds in the Western Rheinisches Schiefergebirge (Utescher, in prep.) showed, that there is a good correspondence of facies development of the southern Dinant syncline (section Eau Noire, section Halma 2, Bultynck & Godefroid, 1974) and sections in the Ahrdorf, Hillesheim and Gerolstein syncline (Eifel Hills).

Bioclastic grain-packstones occur mainly in the lower part of the section Eau Noire (Co 1a, beds 5-6), where they form a minor fining upward cycle : Rounded calcarenites grade into skeletal calcarenites with successively higher contents of small *Girvanella*-aggregates. Cycles of the same type are also general at the base of Heisdorf-Formation in most of the section in the southern Eifel Hills. An increased thickness of rounded calcarenites can be observed in the section Halma 2 (Co 1a, beds 21-33); there they contain also hematitic bioclasts. These components are more common in Heisdorf- and Lauch-Formation of the Eifel Hills, where they were concentrated in shelf sand bodies.

Micrites are common in the unit Co 1b-c of the section Eau Noire (Eau Noire-Formation) he middle and upper part of the Heisdorf-Formation in the southern Eifel Hills. They occur in limestone-marl cycles (dilution cycles). The carbonates are algae- and cortoid-rich bioturbated biogenic wackestones containing a very diverse, mainly parautochthonous fauna.

In the microfacies-subtype, dominating in the Eau Noire-Formation, dasycladaceae (probably belonging to Aciculleleae) are more abundant (5-20 %), Girvanellids and cortoids are commonly sparse; the carbonates are rich in organic matter and intensively bioturbated.

In the southern Eifel Hills a microfacies-subtype with higher contents of *Girvanella*-aggregates (algal mats, broken by bioturbation, 5-25 %) and cortoids is common; dasycladaceae are occasionally present. These carbonates show an higher terrigenous influx.

Both microfacies-subtypes represent muds of shallow (in case of high contents of dasycladaceae less than 30 m) and relatively quiet water below the wave base, which accumulated in sheltered bays or back bank areas.

At the Lower-/Middle Devonian boundary the facies differentiates :
In the section Eau Noire, the sedimentation of Algae-rich wackestones persits till the upper part of the Eau Noire Formation (Co1b-c). In the southern Eifel Hills carbonate sand bars develop, followed by the deposition of biogenic wackestones without indicators of shallow water.

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THE DEVONIAN-CARBONIFEROUS BOUNDARY ON THE DINANT PLATFORM AN APPROACH BY SEQUENCE STRATIGRAPHY

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For the Dinant Platform area (northern edge of the Cornwall-Rhenish Basin) sequence stratigraphy - based on the analysis and relationship of sedimentary facies - is applied for understanding the biostratigraphic problems near the Devonian-Carboniferous Boundary and the stratigraphic pattern in general.

Towards the end of the Devonian, highstand sedimentation (Highstand Systems Tract) - with a rich Devonian-type fauna - ceased as a consequence of a relative sea-level fall. This is reflected by nondeposition and a biostratigraphic gap on the Dinant Platform. This surface of nondeposition on top of the Highstand System Tract is recognised as a Sequence Boundary. After some time, as a result of relative sea-level rise, sedimentation resumed, but in the much shallower setting of the Shelf Margin Systems Tract. these deposits lack the deeper-water guide fauna necessary to biostratigraphically determine the position of the Devonian-Carboniferous (D/C) Boundary in these areas. Later, in the overlying Transgressive Systemps Tract, a high faunal diversity was reestablished, allowing biostratigraphic control.

This sequence stratigraphy approach with the definition of the Sequence Boundary, can be considered to be the best approximation of the Devonian-Carboniferous Boundary in areas without relevant biostratigraphic control.

DEFORMATION-ANALYSIS AND BALANCED CROSS-SECTIONS OF THE WESTERN PART OF THE RHENISH MASSIF : A NEW APPROACH BASED ON STRAIN ANALYSIS

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Geodynamic models concerning the Ardenne and Eifel and the Eastern Rhenish Massif show significant differences. Distinctions in geological evolution and tectonic style prohibit the simple transfer of models from one region to the other.

It is the aim of new quantitative structural investigations in a section from the Nordeifel to the southern border of the Hunsrück to approximate the amount of shortening. Beside external, geometrical measurable deformation the internal deformation will be included by strain-measurements. Especially the last will provide the basis for the balancing of profiles and palinspastic interpretations.

Special focus will be laid on the thin-skinned tectonic of the Nordeifel and the development to a successive deeper reaching crustal imbrication towards the south.

As a result of these investigations it is intended to show up the evolution of the western Rhenish Massif (Nordeifel-Hunsrück) from the basin development through orogenic compression to the postkinematic extension.

U-Pb-AGE DETERMINATIONS ON DETRICAL ZIRCONS OF LOWER DEVONIAN ROCKS OF THE ARDENNE AND THE RHEINISCHES SCHIEFERGEBIRGE

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The U-Pb-isotope-systematics in detrical zircons from lower Devonian sedimentary rocks of the Ardenne and the Rheinisches Schiefergebirge can be used for provenance studies. Three samples taken from the Taunus-anticline, the Ebbe-anticline and from the northern part of the Dinant-syncline show an uniform age-spectrum, in which four different isotopic age-patterns with different geologic records can be identified. There is strong evidence for a magmatic event close to the northern border of the Ebbe-anticline around 500 m.a. The bulk of the lower Devonian detritus though is derived from the Baltic shield as part of the Old Red Continent. These results stand in contrast to those achieved by the same method on Cambrian sedimentary rocks, where Gondwanian source areas are suggested.