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DATA STRUCTURATION IN COAL RESEARCH AND COAL MINING

MARIE-JOSE ROULET

Université Pierre et Marie Curie
Paris, France

I. ABSTRACT

This presentation of data structuration in coal research and coal mining is considered as the first step in the setting up of an operational data bank.

This structuration, according to the HBDS model, seems interesting to take into account many qualitative or/and quantitative data and to manage their relations. This application to drilling data deals with scientific and technical purposes, in coal mine.

II. INTRODUCTION

In France, in the Northern coal-field, identifying coal-seams results of underground drilling campaigns; core-drills are described and rocks' samples analysed in laboratory. The coal winding must also, deals with mining imperatives and human workings.

In a first time, we shall consider the drillings and the description of the core samples. Several geological disciplines are implicated in this example: stratigraphy, lithology, paleontology, sedimentology, mineralogy and tectonic events.

After this fundamental research aspect we try to situate its position in the coal mine exploitation and we present here an outline data structure of the underground and surface fittings in a coal-mine.

III. HBDS

The Hypergraph Based Data Structure (HBDS) with extension about hypercomponents, is defined by its author, as based upon set theory, graph theory and the hypergraph concept.[1,2]

In term of the HBDS model all the data are expressed as: class, object, attribute and link, according to four abstract data types which are set, element, property and relation. The hypercomponents used here are the hyperclasses and hyperlinks.

IV. THE DATA

A. GEOLOGICAL CONTEXT OF DRILLING

The drilling is related to different kinds of studying materials: core-drills, cuttings, diagraphies among other things. Here, using drilling reports we have only, studied the core-drills. The descriptions show the qualitative aspect of the lithology with many guesses on material coarseness, colour and shade, structure or components of the sediments. The paleontological determinations are not easy and they can be uncertain, but they contribute to situate a landmark. All these observations must be followed by special processes in laboratory: coal analysis, tonstein research, sandstone granulometry, heavy minerals determination, spores and pollens research...

After analysing, the results must be put back into a regional context. It is necessary to take into account the known tectonic events, the chronological sequences and the geographical position of the drillings, before coming to a conclusion.

B. COAL-MINING CONTEXT

If it is essential to know the geological position of the coal-seams, it is more important to know the possibilities of mining. These two aspects must be taken into account, and we try to bring a contribution to this second aspect.

The underground mining gives many restraints. The coal-seam is worked in coal-faces which are possibly rushing or turning back, according to its flat or vertical slope. The extracted coal is hauled out through many types of galleries, before to be carried up to the surface, where it is cleaned, sorted out and gauged.

The coal mining is ensured by automated engines, placed in position during the coal-face installation, consequently an electrical feeding is necessary. In order

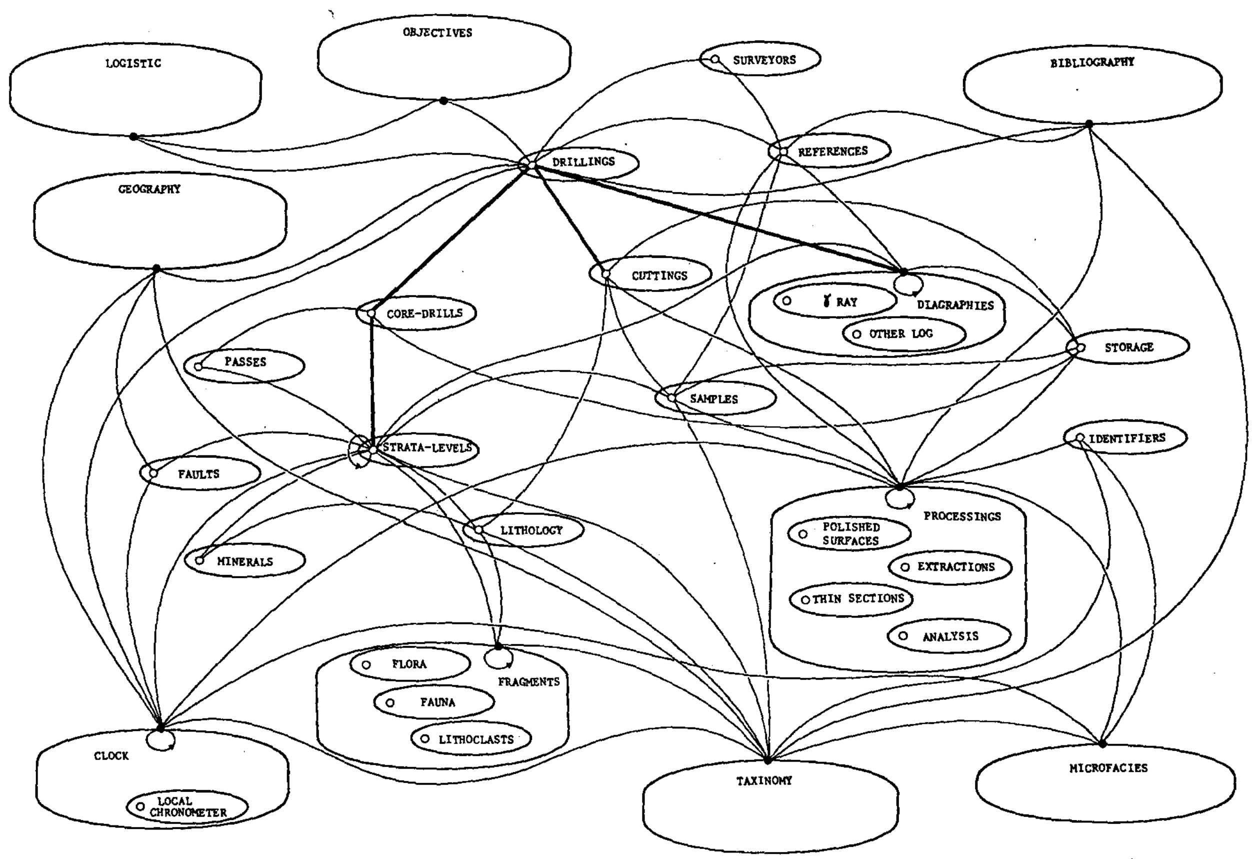


Figure 1. Drilling data structure; general diagram.

to avoid all danger of explosions and fires many injections of water are driven into the worked coal-seams, also, the workings dispose of water and compressed air.

When the coal face advances, the rocks must be supported and the forsaken hollows filled up. These two works must be managed jointly. In all underground mines, there is also safety devices: persistence of effective ventilation in the galleries, quick detection of escapes of dangerous gas, control of the coal and silica dusts. In the galleries, railways allow the running of trains for material, coal, earth and sometimes for workers.

With this enumeration it is possible to see, that the underground mine is fitted up as an industrial installation and must be abble to clear up all kinds of difficulties in the workings.

In addition, the surface fittings ensure the processing and the commercialization of the coal; they have several buildings for winding plant, coal washing, lamp-room, changing-room, coking-plant, power station, management and sale departments. Near each mine, the more evident element in the landscape is the large waste dump.

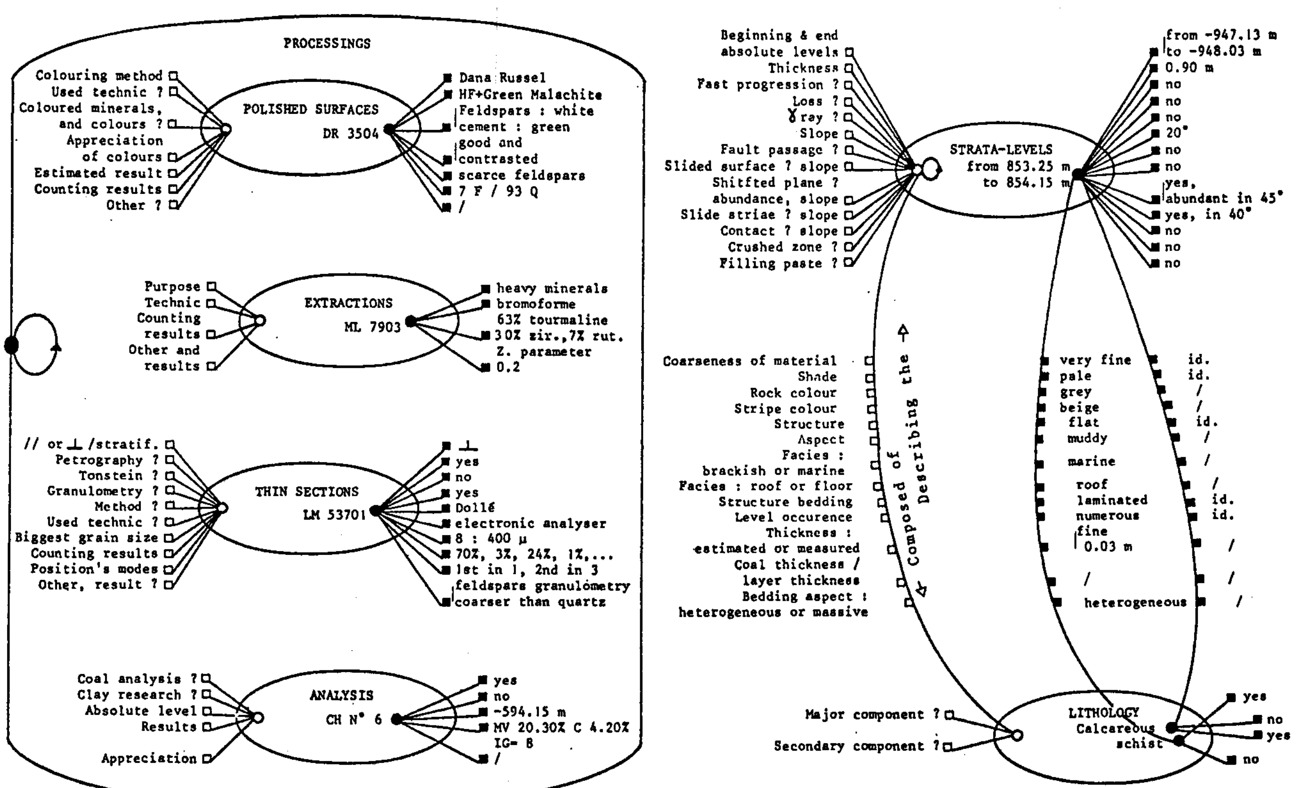
These data show the complexity of the relations between the geological research and this industrial application.

V. DATA STRUCTURATION

A. DRILLING STRUCTURE

The drilling data structure was the first realized and its study is more complete. We present here a general diagram, on figure 1, of this structuration. We can see the coexistence of two types of relations: a hierachical structure (thick line) and a non hierarchical system (curved line), between some classes and hyperclasses.

All the classes and hyperclasses have been recognized with their own objects, attributes and links.[3] In this diagram, all the elements are not detailed, to give a clear survey. They have a complete description in other papers.[4,5].



2a 2b

Fig. 2 : Two examples with concrete objects

- 2a : detail of the hyperclass PROCESSINGS
- 2b : a link with attributes, carrying relations between the two classes STRATA-LEVELS and LITHOLOGY

The class drilling is considered as a set with three sub-sets: cuttings, diagraphies and core-drills with its sub-set: strata levels. Each of them has its attributes and those of its predecessor, if it has one; they indicate the possible properties of an object in these classes.

By the mean of links these classes are related to several classes like: samples, lithology, taxinomy, clock, processings but also surveyors and identifiers, which contribute to the knowledge of the layers and perhaps of a landmark.

B. SOME EXAMPLES

For putting this work in concrete form, two real examples are detailed in figure 2. They firstly concern, the hyperclass "processings" which records the results of the laboratory investigations, and secondly, a particular relation between two classes, carrying attributes, in order to describe the lithology of a given strata level.

1. The figure 2a shows the data organization in case of four treatments used in Northern France coal-field (among others which are not detailed here).

a. In the class polished surfaces, we can take into account the colouring methods which have been proceeded to display some minerals like feldspars, quartz or carbonates. All the attributes of the class receive a specific answer for the object DR 3504: Dana Russel method for a white coloration of feldspars and a green one for cement, the counting results are 7 feldspars and 93 quartz.

b. The class extractions, gives possibility to know about this application of a technic: here, it is heavy minerals which are used to recognize a layer. In this example the object ML 7903 contains 63% of tourmaline, 30% of zircon and 7% of rutile, the analogical parameter of zircons was: 0.2.

c. The thin sections are common means for studying rocks. In this class we can see the different possibilities. In case of a sandstone the results of granulometry appear as attributes of the object LM 53701.

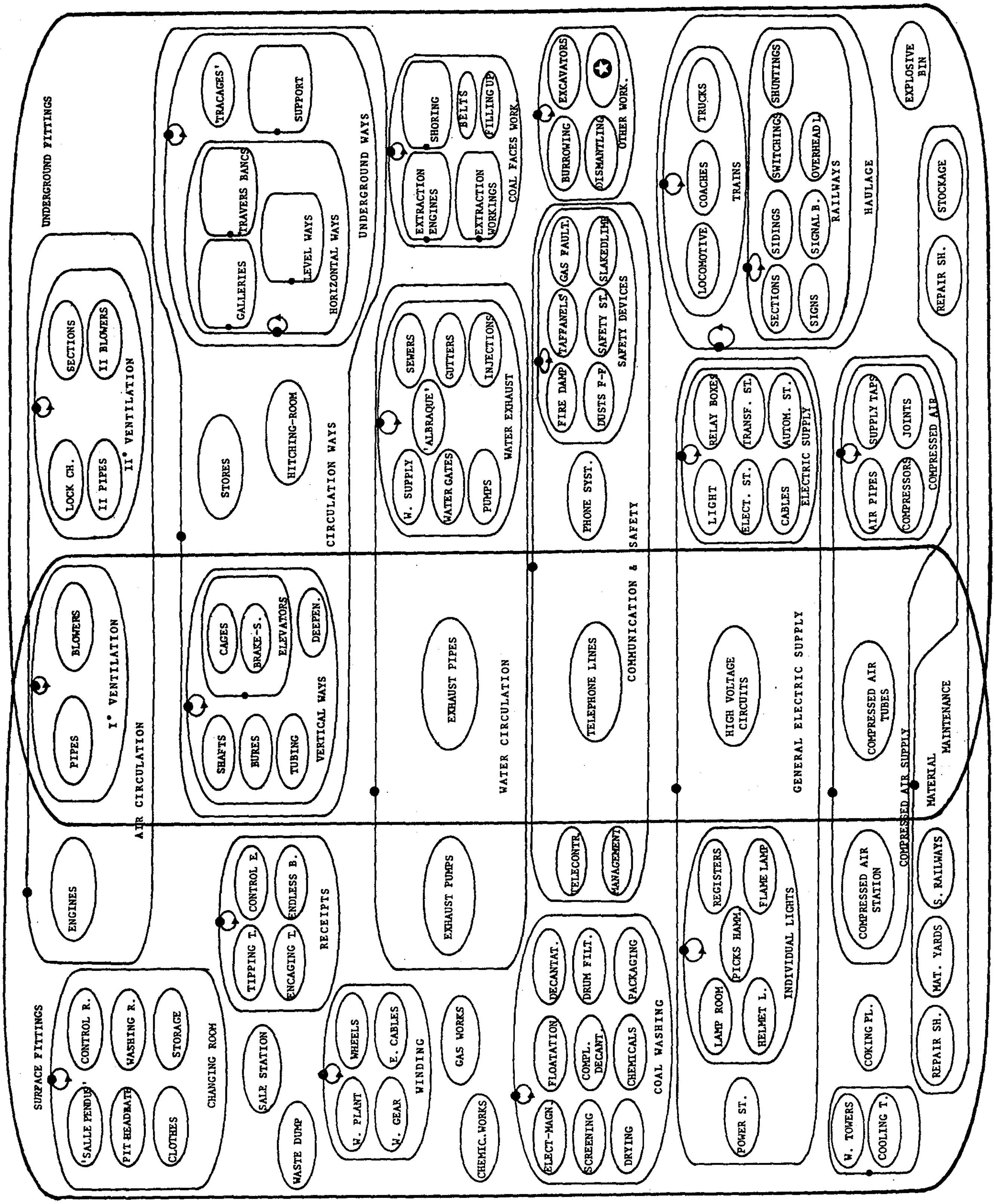


Figure 3. Coal mine structure; general diagram. ✪ indicates the part of drillings in the structure.

d. If there is a coal sample, an analysis allows the exploitation surveyor to define a coal layer produce. Here the attributes of the object Ch n°6 give the percentage of volatile materials and ashes with also a parameter of distension.

But all these objects in the four classes are not isolated, inside the hyperclass they have relations carried by links, because a rock sample can be analyzed by several means (this is symbolized by ⟳ on the figure). The hyperclass itself have many relations as indicated on the general diagram.

2. On figure 2b we can see another kind of data. It is mainly the relation between two classes which is considered.

a. The two classes are strata levels and lithology, the properties of their objects are defined by attributes, as above; with the example processed, it is possible to know the specific answers. Inside the class strata levels a loop-link carry a relation of succession. As above the links with the other classes are not drawn here.

b. Between these two classes the relations are in the first direction: "composed of" and in the opposite: "describing the". The link ensures the description of the components, here it is a calcareous schist bed. This description have many terms, presented as attributes of the link. Indeed, the properties are those of particular components which are realized by this link.

C. COAL MINE STRUCTURE

In order to complete the context of the geological research in coal mine, the figure 3 presents a general outline of coal mining structure. In this diagram we won't give a complete view of the mine organizing but we hope to give a clear picture of an industrial context about a geological drilling problem.

The right of the diagram is relating to the underground fittings and the left is connected with the description of the surface fittings. They are considered, in term of HBDS model, as two hyperclasses; but as we have said above there is an intersection between them, which concerns the middle fittings. In this part we find all that is relating to the shafts, they have to deal with both surface and underground fittings.

Across these two hyperclasses we have chosen to consider seven other hyperclasses which deal with ventilation, traffic ways, circulation of water, safety devices, electric supply, compressed air feeding and work shops. The coal mining needs all of them, but there is also to consider the workings in coal-faces and the drillings to prospect the new workings. The carriage of the coal is taken into account in another hyperclass, and several coal processings in the surface fittings are put into the hyperclass of coal-washing. The winding plant, the receipts and the other buildings like changing-rooms or coking-plant are also presented as hyperclasses. We can't, here, detail all the components; they appear schematized on the figure.

The links between hyperclasses are not drawn to respect a clear presentation. Nevertheless it is easy to conceive the relations which exist between the coal-faces workings, the haulage and the galleries for example. The underground stage ensures the coal and the material carriage, the workers circulation, the feeding of all that is necessary for the workings and the workers; all of these may be presented as links.

VI. CONCLUSION

About the relations, we have not considered the necessary telecontrol of all that is realized in the mine, but it is the first relation to preserve the dangerous consequences of an eventual error.

In this application all the possibilities of the HBDS model are not used, particularly about the fuzziness. In the coal mine all the cases of fuzzy data have been restricted, except the main: the nature. When this application shall be an operational data bank, we hope that it shall be an interesting tool for the management department, therefore it is necessary to create a class where the nature can express itself...

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Marie-José Roulet, graduate of DES de Géologie-Sédimentologie and of DEA de Géologie Stratigraphique, is member of Laboratoire Associé au CNRS n° 215; she works at the Laboratoire de Géodynamique at the Pierre et Marie Curie (Paris VI), as Ingénieur de Recherche. She is also member of the Conseil de Gestion of the Collections de Paléontologie de l' Université. Secrétaire de l'Association des Géologues du Bassin de Paris, she is equally Directeur du Bulletin d'Information des Géologues du Bassin de Paris.