

Conference Report

Expert Systems: can they aid geological interpretation and evaluation?

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This was a one-day meeting convened by P. Vidler and G. Wadge of the Geoscience Information Group at Burlington House on 20 February 1991. The aim was to provide a critical look at how valuable was the current and potential contribution of 'expert system' technology to geological problems. Ten papers were presented to an audience of 39.

In the first of four papers from oil industry applications, **D. Wolstenholme** (BP Research) gave a real time presentation of BIOMARKER, an expert system to evaluate depositional environment. The evaluation is performed from the knowledge of the molecular parameter interpretation technique used by geochemists on organic samples. The system is written in the Prolog language on a Macintosh and performs to 96% accuracy against a test data set. Another system concerned with applying expert knowledge to the interpretation of analytical data was discussed by **L. A. J. Garvie** (Bristol). INTERSTRAT aids the identification of interstratified clay minerals using X-ray diffraction data. The ambiguities and uncertainties in the data, with which the expert system approach is designed to cope, arise from poorly crystalline structure, crystal chemical variability and interstratification of structural layers. The knowledge used by the system embodies diffraction parameters for all the clay minerals and their variations with pretreatments.

A. C. Higgins & P. A. Swaby (BP Research) jointly described a much more ambitious system than the previous two, a visual identification expert system (VIDES) for microfossils. Developed using the expert system shell KEE on a workstation, VIDES is intended as both a training tool and a standard, company-wide reference. It gives access to a large classificatory database from both in-house and literature sources, and allows the user to identify microfossils at the species level from a potential choice of several hundred thousand using comparative onscreen display of target and reference samples. The idea has great potential but major problems include 2D imaging of 3D objects and resistance to its use from the 'experts' themselves.

Basin evaluation has been tackled traditionally in the exploration industry by supporting the exploration geologists with database management tools. **B. T. Wells** (Robertsons) made a strong case for additionally incorporating expert system techniques into this support. He also argued that even the crudest attempts to manage the uncertainties in the evaluation process would be of value in such hybrid database/knowledgebase approaches. The Optimist system described by **P. Clark** (Turing Institute) and **M. Whyatt** (Enterprise) addressed the end of such an evaluation process: the prospect appraisal. This system employs an unusual approach in which the system and user 'argue' about current evaluation of an oil prospect. The system will argue for consistency with decisions made by experts in previous case histories.

The afternoon session focussed on geotechnical and mineral exploration applications of expert systems. **D. G. Toll** (Dur-

ham University) described a geotechnical expert system which is able to assimilate data from boreholes and other sources with a view to creating a soil profile for an area under investigation. The expert system compares this profile with others in its database, allowing assessments to be made of how the soil will affect geotechnical design.

Aerial mapping using high spectral resolution imaging can permit specific mineral maps to be created, despite problems of component mixing, surface shadowing and instrument noise. The AIMLIS package described by **S. Mackin** (DLR Institute for Optoelectronics, Germany) offered a rapid means of extracting the diagnostic features using pattern matching techniques. The expert system generates a probability of mismatch with similar spectra, and examines mis-matches with neighbouring spectra.

G. Wadge & P. A. V. Young (Reading University) illustrated how an expert system had aided a project established to evaluate prospectivity for buried Pb/Zn/F/Ba mineralization. This required the mineralization process resulting from basin dewatering to be modelled. A demonstrator system, BURMIN, used an expert system shell to guide the user through the various steps of mineralization modelling from a multidisciplinary database for the East Midlands. Most mineral exploration projects require large amounts of data and **M. D. Mulvenna** (University of Ulster) described an expert system, EXPLORER, designed to interrogate a large database associated with gold prospecting in Ireland. Ultimately the system had to interpret the other data in terms of their significance to target and pathfinder geochemical elements. **D. D. Hawkes** (Birmingham University) described another expert system for finding gold, appropriately called Gold Finder, this time tuned to Archaean greenstone belts. The main goal was to advise on potential drill sites. Written in Prolog for a Macintosh, the system provided full explanations of its reasoning, and used a real example of a drill site evaluation to illustrate its operation.

On the evidence of the meeting, expert systems are being successfully applied to actual geological problems, although they do not, as yet, appear to have entered the mainstream of geological thinking. Many of the geological expert systems developed to date, including most of those in this meeting, address well-bounded areas of knowledge which are difficult to master, partly because of uncertainties in the data and interpretation. This is the classic area of application of small expert systems that can be developed quite cheaply directly from languages such as Prolog. However, it seems likely that the area where expert systems will find their true home in geological applications will be in aiding the complex multidisciplinary evaluation processes typically encountered in areas such as basin studies. More sophisticated expert system software and its interfacing with spatial databases are required to attempt such tasks.