

## MINERAL SPECIES: EVIDENCE FOR COGNITIVE SEMANTICS

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**Summary :** The debate around the concept 'natural kind' has mainly centred on animals and plants, and consequently on the species concept in biology. The question addressed in this study is whether mineral species as expert, scientific categories are, in fact, classical natural kinds, as is currently accepted in theoretical terminology studies. Based on an empirical study of the features used by expert mineralogists to define mineral species, the findings of this study support the view that mineral species are experiential, prototype categories rather than classical, objective categories. These prototype categories are represented within idealized cognitive models which can be characterised in terms of certain image-schemas such as the CONTAINER schema, the UP-DOWN schema, the PART-WHOLE schema and the LINEAR ORDER schema.

**Keywords :** natural kinds, mineral species, defining features, terminology, cognitive semantics, prototype theory, idealized cognitive models, image schemas

### 1. INTRODUCTION

Traditionally, the world has been classified into animal, vegetable and mineral. Similarly, the examples that are normally given of so-called natural kinds are animals, plants and minerals. The debate around the concept 'natural kind' has, however, mainly centred on animals and plants, and consequently on the species concept in

biology. The question addressed in this study is whether mineral species as expert, scientific categories are, in fact, classical natural kinds.

## 2. METHODOLOGY

The study reported on in this paper forms part of a larger project in which the nature of scientific terms and the categories they represent is investigated. This larger project owes its existence to the typical problems encountered in consulting work done for the National Terminology Service. In this paper the nature of mineral classification as the most fundamental 'devised classification system' of the earth sciences is investigated. The general hypothesis of this study was formulated as follows:

Mineral species, as scientific categories, are experiential, prototype categories and not objective, classical categories, and their conceptual content is therefore best described in terms of idealized cognitive models as proposed in prototype theory.

According to Geeraerts (1989: 592) prototype categories have the following four features:

- prototypical categories cannot be defined by means of a single set of criterial features;
- prototypical categories exhibit a family-resemblance structure, i.e. their semantic structure takes the form of a radial set of clustered and overlapping meanings;
- prototypical categories exhibit degrees of membership; and
- prototypical categories are blurred at the edges.

According to Geeraerts, only one of these characteristics of prototypicality needs to be attested in a category to show that it is a prototype category. The specific hypothesis of this study was therefore formulated as follows:

The features used to define mineral species, as scientific categories, are not the criterial, objective features of the classical theory of categorization, but are the culturally and perceptually based interactional attributes of prototype theory.

Four standard specialized reference texts were consulted to investigate the features that are used to define individual mineral species. The features used in these texts were compared to the checklist for new mineral proposals of the **Commission for New Minerals and Minerals Names (CNMMN)** of the **International Mineralogical Association (IMA)**, a very powerful international standardizing body. Standard text books in mineralogy and four specialist mineralogists were consulted on an ongoing basis. Since there are an infinite number of possible defining features (such as, numerical values or colour combinations) the focus was on classes of features, or on parameters (such as colour), rather than on individual features.

### 3. THE FINDINGS

The specific hypothesis of this study, namely that the features used to define mineral species are not the criterial, objective features of the classical theory of categorization, but are the culturally- and perceptually-based interactional attributes of prototype theory, was reported on in a paper «The defining features of scientific concepts» (Zawada 1994). As reported in this paper:

These conclusions show that the nature of the features used to define mineralogical concepts differ markedly from the views ... that the defining features of scientific concepts are the fixed, inherent, essential properties (i.e. decontextualized necessary and sufficient conditions) of the classical approach to categorization. ... This study has, however, confirmed that even the features used to define scientific concepts should be regarded as the interactional properties of prototype theory, and not as the classical definitional features of the decompositional approach to meaning (Zawada 1994: 311-312).

This study also supports an experiential cognition (even for experts), as opposed to the reference-based objectivist cognition that is normally accepted with the classical theory of categorization. A reference-based, objectivist view of cognition typically subscribes to the following doctrines:

- Fixed and mind-free entities, properties and relations exist in the world.
- Entities in the world are divided into natural kinds, that are definable by essential properties.
- Complex properties are logical combinations of primitive properties.
- Meaning is based on reference and truth.
- Truth consists in the correspondence between symbols and states of affairs in the world.
- There is an «objectively correct» way to associate symbols with things in the world.

This study, however, came to the following conclusions:

- Mineral species are real-world phenomena, but the mental constructs we use to understand them are not only perceptually and culturally based, but are embedded in rich cognitive models.
- Natural kinds such as minerals are not always simplistically definable in terms of necessary and sufficient conditions.
- Complex properties operate in terms of holistic gestalts which are 'more' than the sum of the primitive properties.
- The objective values of defining features are only meaningful in terms of generally accepted standards or norms.
- The 'truth' of the values of defining features can only be verified in terms of the same standards or norms.
- Defining features and categories are dependent on functional and contextual constraints.

On the basis of these findings, the general hypothesis, namely that mineral species are experiential, prototype categories and not objective, classical categories, is accepted.

#### 4. THE PROPOSALS

One of the claims of prototype theory is that it provides adequate mechanisms for describing the conceptual structure of specific domains. This study supports the view proposed by Lakoff (1987) that concepts, even expert scientific concepts (and the categories they represent), are elements in complex and interrelated cognitive models. McCauley (1987: 292) makes the suggestion that

Idealized cognitive models are simplified mental constructs that organize various domains of human experience, both practical and theoretical. Theories should, perhaps, be construed simply as the more elaborate and complex of our idealized cognitive models.

Following McCauley (1987), I would like to propose that scientific theories are a specific type of cognitive model that are more systematic and formalized than the cognitive models that structure other areas of human experience. According to Lakoff (1987: 284 - 285), each cognitive model (ICM) is a complex symbolic structure, consisting of certain elements and certain types of structure that characterize the relations between the elements.

Three detailed proposals are made in which the following problematic categorization tasks are characterized in terms of idealized cognitive models that are independently motivated:

- (i) the general classification system in mineralogy,
- (ii) the general concept 'mineral', and
- (iii) the classification of specific individual minerals as belonging to particular mineral species.

The cognitive models that are used to characterize these types of categorization are elaborations of the following image schemas: the CONTAINER schema, the UP-DOWN schema, the PART-WHOLE schema and the LINEAR ORDER schema.

These proposals explain

- (i) the interaction of the underlying chemical, physical and environmental models in classifying minerals,
- (ii) the conceptual link between the general concept 'mineral' and the classification of individual minerals as belonging to a particular species, and
- (iii) the existence of typical cases (so-called type specimens) and ideal cases (in the form of beautiful or rare specimens) housed in geological museums.

#### 5. CONCLUSION

This study has shown that mineral species as expert scientific categories are not objective, classical categories, but are experiential, prototype categories that can be described in terms of idealized cognitive models. The results of this research project

has two significant implications:

- The working semanticist can no longer afford to work within an objectivist, classical framework where classical criterial features are merely listed, but has to work with the concept of rich cognitive models to describe the meanings of words, whether they are common-language words or terms.
- Expert, scientific categories (named by terms) are structured and can be characterized in exactly the same way as everyday folk categories (named by common-language words), which means that the great divide between terminologists and lexicologists should be abandoned.

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