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CLAY SCIENCE FROM THE PUBLICATION AND CITATION ANALYSIS PERSPECTIVE

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Abstract: The publication production of clay minerals is analysed on the basis of the works registered in the SCI database in 1980–2001. A continuous increase of the annual number of works in this period is registered while the proportion of the number of works devoted to individual clay minerals remains almost unchanged throughout the whole period. The subject of publication production is substantially dependent on the type of mineral followed; material research oriented papers, catalysis and organo/clay interactions research prevail among the papers with a chemical character. The average citation response to the set of analysed papers is about 10–15 citations/paper and uncited papers represent 9–35 % of the total number of papers. The most cited papers (in individual years) are cited on average 109-times annually and half-time of the citations count per paper exceeds 20 years. The average time between appearing and the greatest citation response can be estimated at 5 years.

Key words: citation analysis, publication production, clay minerals.

Introduction

Clay minerals research covers, due to its interdisciplinary character, the scientific fields of geology, pedology, chemistry, environmental sciences and even astronomy. The use of clay minerals is wide and includes not only basic research methodologies, but also a large spectrum of industrial and technical applications. Subject diversity of papers and the wide variety of journals in which the papers are published show the heterogeneity of clay research. Though this character of clay research is well known there are no reliable statistical data to prove this statement. One possible way to tackle this problem is evaluation of the number of journals where works on clays appear. Such an attempt was made in 1998 (Jesenák & Kuchta 1998). The results show that chemical works dealing with clays appear in approximately 800 scientific journals. This fact can be quite surprising for a major part of the community working in this scientific field. It is mainly due to the great popularity of periodicals selecting only a small part of the total publication production in this field. A detailed description of the situation in the clay science publication activity was published in (Jesenák & Kuchta 1998; Jesenák & Kuchta 1993) aiming not only at quantification of the known facts about the character of scientific production, but also at documentation of long term trends in this field. However, some of the data were outdated already at the time of appearance of the work (Jesenák & Kuchta 1998).

The objective of this work is to provide an up-to-date survey of publication production in clay science. A pronounced difference between papers mentioned above and the present work is that the present survey is not limited to the works of chemical character, but involves all fields of natural sciences.

Methods

An electronic database of the SCI periodical, which was freely available on the Internet (web page of Institute for Scientific Information, Philadelphia, USA) in May 2001, was used for analysis. Concerning the philosophy of the SCI database architecture, the analysed set comprises quite narrow, but important groups of works from all scientific fields.

The analysed set included bibliographic data from all works registered in the SCI in 1980–2001 where the name of any clay mineral was found as a key word. A program associated with the SCI database was applied for selection of relevant data; some MS DOS programs were created by the authors and applied for special tasks.

Results and discussion

The trend in the number of the papers with the key word "montmorillonite" in the last 20 years is shown in Fig. 1. A stabilized situation in 1980–1990 is followed by a period of continuous growth. Considering the trend in 1930–1997 worked out from the Chemical Abstracts (CA) database (Jesenák & Kuchta 1998), which shows an almost stabilized situation since the late 1980s, the increase of registered publication count in the early 1990s can be explained by a change of the SCI database processing conception and possibly by some changes in the organizational system and technical equipment rather than by a real growth of the published papers. This opinion is supported by the fact that the turning point goes back to the period of revolutionary changes of technical equipment and information services. It is assumed that ascendant charac-

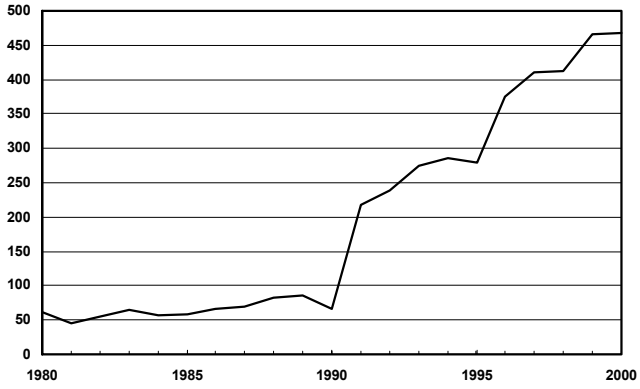

Fig. 1. Number of works (y-axis) with the key word "montmorillonite", registered in the SCI in 1980–2000.

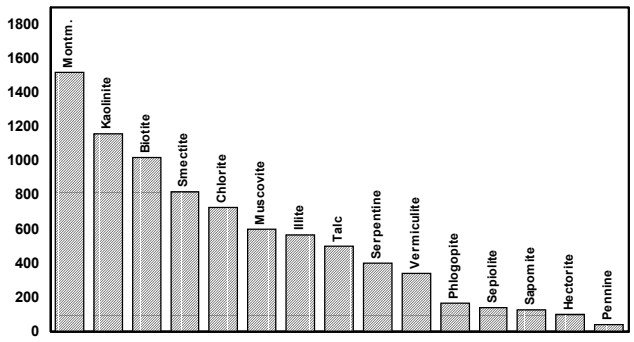

Fig. 2. Number of papers dealing with individual clay minerals registered in the SCI in period from 1980 to 2000.

ter of the curve for the late 1990s is an expression of a real trend in the development of publication activity. Fig. 1 suggests that the SCI database could hardly be considered a reliable basis for literature review in clay science until the end of 1980s. But the situation improved dramatically in the early 1990s and currently the annual number of registered papers approaches the number of papers registered in CA. It should be emphasised that in spite of the large overlap of both sets (SCI–CA), these sets are not identical.

Fig. 2 shows the subject orientation of the publication production in 1998–2000. Compared with a similar histogram from CA for almost 70 years (1931–1997) no significant changes are found, but exchange of neighbouring positions. Montmorillonite can be evaluated as the long term most cited clay mineral. From the subject point of view, sets of papers on individual clay minerals differ significantly. A special position belongs to the papers on montmorillonite due to their high degree of heterogeneity (Fig. 3). In the papers on montmorillonite a chemical character prevails in contrast to the predominantly geological orientation of papers dealing with other clay minerals. Besides the classical montmorillonite topics "sorption" and "catalysis", a great part of the papers can be classified as material science. The proportion of papers on montmorillonite-organic interaction is higher than that on montmorillonite-inorganic interaction. However, considering the vast prevalence of numbers of existing organic over inorganic compounds, montmorillonite-inorganic interactions appear of greater importance. The proportion of papers dealing with sorption of radionuclides is currently much lower than 20 years ago. Papers with the subject "vermiculite" represent a certain transition between papers on montmorillonite and other clay minerals, with a rather high proportion of chemical works.

The evaluation of scientific importance of publication activity is often derived from the citation response. Though this work should not be looked at as a support for this opinion, it provides necessary data for such considerations. For this purpose, only papers with the key word "montmorillonite" published in 1980–2000 were used since the number of hits in the whole analysed set is too large and processing would be uncomfortable. If citations from 1998–2000 are not taken into account (they represent only a small proportion of the total num-

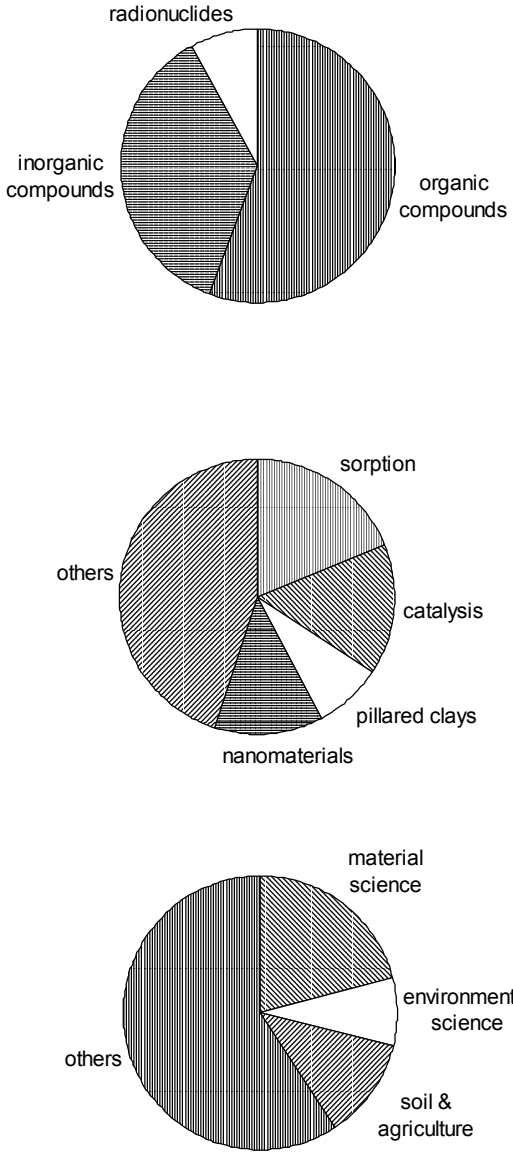

Fig. 3. Subject orientation of current publication production on montmorillonite and mutual proportion of works in group "sorption" (works registered in the SCI in 1998–2000).

ber of citations), citation counts per one paper in this set varies in a narrow range from 21 to 56 citations with an average of 36 citations/paper. It is quite interesting that almost exclusively the two most cited works are responsible for the extent of the range (minimum and maximum citations) while the values for other papers are near the average. The average value for the 10 most cited works within the whole set is 109 citations/hit. The subject orientation of a given set of papers with the greatest citation response represents approximately the whole publication production in this research field (Table 1). Fig. 5 shows the average citation count per work of the 10 most significant works published in the year 1980. Provided that we ignore an initial part of the curve (1980), the average citation count/paper varies around 18 citations/paper. The half-time of citation count/paper in this group of papers far exceeds 20 years which is considered a very high value in natural sciences. If the whole group of all published papers is considered, the average time between appearance of a paper in a journal and its citation "reaction" is approximately 5 years. Fig. 4 shows the citation counts for the 6 most cited papers in a given year.

An average number of citations per paper in the whole analysed set varies in a narrow range of 10 to 15 citations/paper. Uncited publications comprise some 10 to 35 % of the total number of published works. We assume that the average citation counts/paper of the whole publication production in clay research would be significantly lower. This situation is partly caused by lasting difficulties with finding relevant information — these troubles are obviously of a general character and not confined to clay research. This situation is, of course, inconsistent with present possibilities of information services. It could be explained by unattainable prices for complete infor-

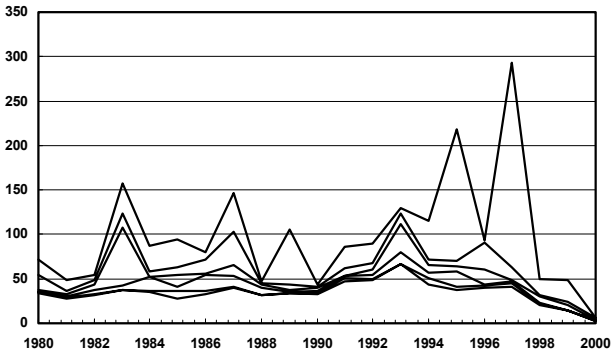

Fig. 4. Citation counts in individual years (y-axis) registered in the SCI for the 6 most cited papers on montmorillonite.

Table 1: 20 papers with highest citation index registered in the SCI database in 1980–2001 (C. C. — citation counts).

C. C.	Paper
293	Corma 1997: From microporous to mesoporous molecular sieve materials and their use in catalysis. *Chemical Reviews*
218	Lvov et al. 1995: Assembly of multycomponent protein films by means of electrostatic layer-by-layer adsorption. *Journal of American Chemical Society*
157	Occelli & Tindwa 1983: Physicochemical properties of montmorillonite interlayered with cationic oxyaluminum pillars. *Clays and Clay Minerals*
146	Sterte 1986: Synthesis and properties of titanium-oxide cross-linked montmorillonite. *Clays and Clay Minerals*
129	Usuki et al. 1993: Synthesis of nylon 6-clay hybrid. *Journal of Materials Research*
115	Gu et al. 1994: Adsorption and desorption of natural organic-matter on iron-oxide — mechanisms and models. *Environmental Science & Technology*
105	Clark et al. 1989: Montmorillonite supported transition-metal salts as Friedel-Crafts alkylation catalysts. *Journal of Chemical Society – Chemical communications*
95	Ege et al. 1985: Clay modified electrodes. 3. Electrochemical and electron-spin resonance studies of montmorillonite layers. *Journal of American Chemical Society*
93	Xing et al. 1996: Competitive sorption between atrazine and other organic compounds in soils and model sorbents. *Environmental Science & Technology*
90	Aranda & Ruizhitzky 1992: Poly(ethylen oxide)-silicate intercalation materials. *Chemistry of Materials*
87	Yamanaka et al. 1984: High surface-area solids obtained by intercalation of iron-oxide pillars in montmorillonite. *Materials Research Bulletin*
86	Koide 1991: Nutrient supply, nutrient demand and plant-response to mycorrhizal infection. *New Phytologist*
80	White & Bard 1986: Clay modified electrodes. 4. The electrochemistry and electron-spin-resonance of methyl viologen incorporated into montmorillonite films. *Journal of Electroanalytical Chemistry*
71	Oster et al. 1980: Flocculation value and gel structure of sodium-calcium montmorillonite and illite suspensions. *Soil Science Society of America Journal*
55	Plenchette et al. 1982: Effects of different endomycorrhizal fungi on 5 host plants grown on calcined montmorillonite clay. *Journal of the American Society for Horticultural Science*
50	Clark & Macquarrie 1998: Catalysis of liquid phase organic reactions using chemically modified mesoporous inorganic solids. *Chemical Communications*
49	Johnson et al. 1999: Ordered mesoporous polymers of tunable pore size from colloidal silica templates. *Science*
48	Keren et al. 1981: pH-dependent boron adsorption by Na-montmorillonite. *Soil Science Society of America Journal*
47	Kawai et al.1988: New application of solid acid to carbon-carbon bond formation reactios — clay montmorillonite-catalyzed aldol reactions of silyl enol ethers with aldehydes and acetals. *Bulletin of the Chemical Society of Japan*
44	Barloy et al. 1990: Manganese porphyrins supported on montmorillonite as hydrocarbon monooxygenation catalysts – particular efficiency for linear alkane hydroxylation. *Journal of Chemical Society – Chemical communications*

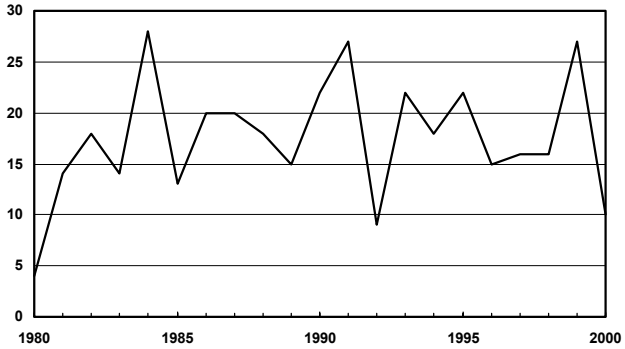

Fig. 5. Illustration of citation count change of the 10 most important papers (average value) published in 1980, assessed on the basis of the SCI citation counts per paper.

mation, at least in Central and Eastern European countries. In this respect, the high degree of diversification of journals on clays plays an important role, which has a very negative effect, particularly on compilation of retrospective literature reviews. It is just this fact, which is crucial in the unnatural outdating of information. It is questionable whether the present major orientation to review periodicals, such as Current Contents (and also SCI) is, from the statistical point of view, an inevitable consequence of present possibilities or a manifestation of a free research philosophy.

Conclusion

The analysis of publication production in clay science field offers possibilities for its objective evaluation and comparison with production in other scientific fields. It is well known that such evaluation is often used as a reason for justification of the meaningfulness of research programs as well as their backward evaluation. Opening of discussion about the philosophy, strategy and organization of research information services at academic workplaces in Slovakia can be considered as a by-product of this analysis.

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