# Central Laboratory of Mineralogy & Crystallography (CLMC) - 509

## Executive Summary

CLMC has many assets: well-developed international co-operation; expertise in running complex analytical techniques; openness toward national needs in matters of materials' analyses; significant publication records. The main issue to be addressed and resolved in the near future is how to keep developing further analytical services and, at the same time, make the basic research activities converge toward an overall scientific programme agreed upon by the active CLMC's research teams; a solution to this issue will help to attract more young professionals, more interested in either basic science or in getting advanced professional training/experience in analytical skills.

## (a) Quality and productivity

***Quality***

CLMC has an excellent team under young and dynamic leadership. The team has been successful in counteracting the brain-drain of young scientists, by attracting gifted young Bulgarian researchers from abroad. Four Humboldt Fellowships have been awarded to members of the team.

Achievements of 3 PhD-awarded outstanding students and of 5 PhD students are remarkable and a series of scientific topics have been worked out in the past few years, at the highest level.

The total number of positions opened at CLMC (55) makes it a middle-sized Institute and more than 1/10 are reported "administration positions" (6); it is not clear what the "subsidiary division" is; if aggregated to "administration", the latter jumps up to ¼ of the total work-force of the Central Laboratory. The age distribution is given for 44 staff members, i.e. more than the positions distributed among the scientific/technical departments of the CLMC (40), but less than the Central Laboratory's total staff: it makes it difficult to interpret; yet, the striking feature is that the peak of the distribution is in the range 46-50, with a marked skewness toward higher ages; the reverse would be much more favourable for the Central Laboratory as a whole; yet the overall situation is not bad, provided that, in the near future, opportunities of hiring young scientists make it possible to complement and/or replace the work capacity of the Institute. A finer comparative analysis bearing on the age distribution of researchers strongly engaged in co-operation abroad, and those remaining "at home", is needed for a better appraisal of the problems and before hiring new staff.

Some scientists at CLMC are involved in the overall life of the discipline; in particular in the review of papers submitted to scientific journals. It could be wise to concentrate (partially) on "in-house" original science.

Some information was given on the analytical instruments currently available (transmission electronic microscope, crystal X-ray diffractometer, FT-IR spectrometer, ...), supplemented by the Panel's visit to the Institute: all those "old" instruments have been carefully maintained and kept productive for many years, much more than the life duration usually expected; at the same time, the physical environment of the

instruments has obviously not benefited from the same care and some new pieces of equipment (like the scanning electron microscope) will require much better attention as for their physical environment. The same holds, mutatis mutandis, for the new equipment they aim to obtain (like the laser-abrasion mass-spectrometer); the idea of setting up a consortium with other organizations (within and/or outside the BAS) to buy an expensive piece of equipment is very much welcome and should be firmly encouraged and will, no doubt, prove effective; the conditions, both in the conditions of the personnel and physical environment, for properly accommodating the newly acquired instrument should be seriously considered..

***Productivity***

Overall scientific activity at CLMC, as measured through publications, is quite impressive; they publish in high-quality peer-reviewed international journals; a possibly major weakness comes from the large amount of activity actually performed in institutions abroad since quite a few productive scientists (in terms of researcher-months) are very often away from the Central Laboratory; this is fine per se, but the obvious danger is a rampant brain-drain. Nevertheless, it became apparent during the visit and through the discussions that this possible adverse effect was more or less under control, as far as feasible; in particular, quite often CLMC's scientists are first authors of common publications. A tendency to be kept under strict control regarding the "opportunity" of publishing after having performed ordered analytical work is another potential danger; the analysts involved are entitled to be included in the list of authors of any publication drawing upon the analytical results obtained, but not necessarily among the leading authors; this does not seem to raise problems in the present situation in which the initiative of investigating the topics remains essentially in the hands of the scientists. Anyway, CLMC's scientists should be permanently encouraged to publish their results in worldwide-renowned scientific journals.

161 papers mostly in prominent international journals are reported over 5 years. The most striking feature is the extreme variety of subjects, from Mineralogy/Geology sensu stricto, to coal combustion products, or dental matter. Most probably, many should be regarded as the (sometimes long-term) outcome of visits to foreign labs; this interpretation is supported by comparing the list of publications in "scientific journals abroad" (161 referred articles) and the list of publications in "scientific journals in Bulgaria" (84); the ratio is 2/1, whereas one would have a priori expected the reverse: this is a good asset; it is further featured by the average numbers of authors per paper: 4.03 for publications abroad as compared to 2.76 for publications in Bulgaria. Most probably, Bulgarian authors aggregate research teams already established while abroad. CLMC's researchers actively look toward foreign-institutions for co-operation, at least for some of the topics investigated.

There is limited transfer of knowledge from CLMC to "clients": CLMC acts as a simple-commerce service provider, especially when performing straightforward analyses. The intellectual benefit of such operations for CLMC is unclear. Initiatives at investigating specific topics are most often taken by the CLMC's researchers on scientific grounds; a further step, still to be achieved, is to try to attract the interest of potential users in the results obtained.

Overall, this Institute is composed of a highly motivated research team with a young and dynamic leadership and its holds a strong potential for excellent research in the near

future, also in view of its demonstrated capability to attract outstanding young scientists and funding for new equipment and infrastructure.

**Overall score for Quality and Productivity: "A"**, for "*work that is internationally competitive. The Institute has demonstrated important contributions to the field and is considered an international player.*"

### (b) Socio-economic Impact

Obviously, the domain of activity of CLMC is highly relevant for Bulgaria; the importance of mineral resources in the country would be a sufficient justification.

On a more general background, many scientists are reported as having participated in teaching activities: a significant number of teaching hours are reported (889 + 1361 hrs. over the 5-year period). This looks a priori very good, but scientists, devoting too much time for teaching without a significant number of bachelor and master degrees awarded, are expected to not have enough time for research activities.

A clear bias appears, in international research projects, in favour of former "eastern European block"; it is straightforward as long as BAS is officially a party in, as it allows co-operation with very limited currency implications; for other co-operation projects, apparent bias is significantly attenuated in other context: the contacts with scientists from western European countries are quite developed.

**Overall score for Socio-economic Impact: "*Highly relevant*."**

### (c) Prospects

Impressive professional skills are currently available at CLMC. The Institute has many ideas for further developments both in topics to be investigated and in increased analytical capabilities. The personnel's age structure is not unfavourable. The Institute's management is decidedly oriented toward enhanced co-operation, both among the BAS Institutes and with other organizations. The outlook is very good for CLMC; efforts for further integration with other BAS Institutes programmes should be encouraged.

The main problem of CLMC lies in the personnel issue, apart from the overall age distribution:

i) It is noticeable that only one "senior research fellow Degree I" shows up in the personnel list of the Central Laboratory; only two Dr.Sc. are in the staff;

ii) Because of the extremely focused research topics and the necessity of advanced analytical resources, but also because of the demand from outside, an obvious tendency to extroversion prevails over introversion with respect to CLMC, if one disregards the "Service Laboratory Department" for which activity is naturally strongly related to the service of "clients" in the broadest sense). The corollary is that this extroversion leads to impressive CLMC co-operation records. On the other hand, better introversion would automatically lead to more CLMC "endogenous" basic science being developed. This is clearly a matter of policy within CLMC, and BAS of course;

iii) The prevailing extroversion underlined above explains partly why finally overall-limited student training takes place within CLMC, although there could be also some

structural reasons as well, such as the widespread problem of scarce remuneration in the public-domain research sector. Nevertheless, getting higher education skills, even though one knows that the professional career will not develop within a definite-scientific environment, could still remain attractive, especially in the domain where students would at least gain professional experience by using high-tech equipment and advanced work methods. Anyway; activity better centred on "in house" basic science topics would help CLMC attracting, for a definite duration at least, more PhD students. Actually, the Laboratory puts a major emphasis on human resources.

**Overall score for Prospects: "*High.*"**

## Overall Strengths and Weaknesses

*Strengths:*

The main strengths of CLMC are professionalism (in particular, in mastering advanced, sophisticated analytical instruments); openness to co-operation, inside and outside BAS; numerous contacts with the economic world, at least within Bulgaria; good insertion in the worldwide community (co-operations, mutual working visits, publications in common).

*Weaknesses:*

The main weaknesses are dispersion (from solid-state physics to "applied-geology" mineralogy [ore deposits]), not enough clear focus on "in house" research lines and difficulties in hiring young scientists.

## Recommendations

The main recommendation is to have a clearly stated science policy for the Institute. Having many research fellows working on many different topics under co-operation schemes and involving many domestic and/or foreign institutions does not make up a science policy. It is important that the Laboratory maintain a definite priority on quality.

The team has been very pro-active in the successful acquisition of new instruments in consortia with other BAS Institutes: this should be further encouraged.

The opportunity of keeping under CLMC the traditional wide range of sub-domains historically grouped under "Mineralogy and Crystallography" (or even further including "materials science"), must be investigated and addressed. The same holds about whether to develop further analytical services oriented toward the "analyses market", academic and/or industrial, or to remain an Institute mainly oriented toward "in house"-defined basic research activity in the Earth's sciences.

In this context, the Panel endorses the ambition of the Laboratory to establish a "centre of excellence" in mineralogy, crystallography and material science.