

# REPORT

## Roundtable Discussion on Value Addition of Graphite



## ORGANISING TEAM

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# CONTENTS

**Executive summary**

4

**Agenda (roundtable discussion)**

6

**Objectives**

7

**Presentation at-a-glance**

8

**Panel discussion**

12

**Key recommendations**

15

**Annex I Details of participants**

16

## EXECUTIVE SUMMARY

The primary objective of the Coordinating Secretariat for Science and Technology (COSTI) is to join hands with the government to improve high tech exports from 1.5% to 10% by 2016. It had identified graphite as a substance that can yield exorbitant profits in the future, provided it is properly used for the production of hi-tech goods.

In order to facilitate the hi-tech value addition procedure, COSTI organized a round table discussion on graphite on 9th of January, 2014 at Sri Lanka Foundation Institute (SLFI) lecture hall - 3 at No.100, Sri Lanka Padanam Mawatha, Independence Square, Colombo 7. The purpose of this round table discussion is to form an interaction between the industry and the researchers scattered throughout the country and also to discuss their strengths, weaknesses, opportunities, threats and seek ways and means to overcome their problems. As such, this report presents a summary of presentations made by the speakers and the valuable points emphasized during the roundtable discussion.

People involved in research relating to graphite from Universities and all other research institutes along with people involved in industry and trade participated for this event. Presence of the Hon. Senior Minister for Scientific Affairs Prof. Tissa Vitharana provided considerable encouragement and assurance to the participants and his speech clearly indicated his interest to safeguard country's mineral resources. On the other hand, the minister's presence and his speech was an incentive for participants to speculate the possible mineral policy change that could benefit the country. As a first step in initiating this program, Prof. Ajith de Alwis, Project Director COSTI, delivered the welcome address and emphasized the program's objectives.

The roundtable discussion was enriched by presentations from several resource people from universities, research organizations and the industry. They shared their valuable research findings, their problems and possible solutions so far not revealed to any media. As such, for those involved in this trade this event was a tremendous opportunity to publicize their findings and to solve their problems.

Thereafter, a panel discussion took place under the chairmanship of Dr. Mubarak. It was on topics such as exploration, conventional processing, value addition, etc. The industry as well as research institutes raised a number of important issues and some of the problems were partially solved then and there with the cooperation of panel participants. One such issue discussed was an impediment due to the government restriction on import of some chemicals required for stabilizing graphite during the processing and several solutions to fix the problem were presented by the panel members. One other important point discussed was that some other ingredients necessary for the production of high-tech products of graphite need to be exported from elsewhere and they were quite expensive. One solution that came to light from panel itself is that some of the ingredients can be found within Sri

Lanka. The last point highlighted was that some high-tech productions are energy intensive and are not feasible because energy is a very expensive commodity in Sri Lanka. One noteworthy observation is that these same processes were carried out in India under very mild energy consumption and the same methodology can be applied in Sri Lanka as well. Likewise, most of the problems were solved within the panel itself. Another most ingenious thought is to contemplate whether one could limit the production to graphene or go beyond that. If we are successful in graphene it can be used for a number of high-tech products which can bring exorbitant profits to the country. How far these suggestions are feasible has to be seen once applied to the real scenario and their success may take some time. Hence, there is the expectation that if everything goes well another golden era for the graphite is in the offing in the near future.

For detailed description of the workshop proceedings, key outcomes and the personnel involved the reader may refer to the main report.

## AGENDA (Round table discussion)

### COSTI Roundtable Discussion Series: Value Addition of Graphite

9<sup>th</sup> January 2014 at Sri Lanka Foundation Institute (SLFI), lecture hall No.3, No. 100,  
Sri Lanka Padanam Mawatha, Independence Square, Colombo 7

- 09.00 am Welcome and objectives, Prof. Ajith De Alwis, COSTI.
- 09.15 am Address made by Prof. Tissa Vitarana, Hon. Minister (Senior) for Scientific Affairs
- 09.30 am Graphite exploration, mining and applications.  
Dr. Rohan Fernando, Open University of Sri Lanka (OUSL).
- 09.45 am Graphite Industry, regulatory affairs and future trends.  
Mr. Dulip Jayawardena, Former Director Geological Survey Department (present GSMB) and State Graphite Corporation.
- 10.00 am Research related to hi-tech products, especially, graphene.  
Dr. Dilushan Jayasundara, Sri Lanka Institute of Nano Technology (SLINTEC).
- 10.15 am Graphite Industry and the scope of its value addition.  
Mr. D. Kalansooriya, Chairman, Kahatagaha Graphite Lanka Limited.
- 10.30 am Ongoing research relating to graphite at University of Peradeniya  
Dr. H.M.T.G.A. Pitawala, University of Peradeniya
- 
- 11.00 am Panel discussion.  
Chaired by Dr. Mubarak, COSTI
- 12.30 pm Concluding remarks and vote of thanks.  
Dr. Prashan Francis, COSTI
- 12.40 pm 

## OBJECTIVES (Round table discussion)

The roundtable discussion on graphite was organized with the following objectives:

- ❖ Promote the mineral industry of the country by forming a network or interlink among the researchers involved in the graphite and the industry to harness the maximum profit out of our raw graphite mineral.
- ❖ Provide a common platform for people having the same interest to assemble and discuss their problems; thereafter, find solutions for them during the discussion.
- ❖ To form graphite cluster found within the virtual institute on mineral resources and formulate an operational mechanism during the discussion.
- ❖ Identify the ways and means to increase the country's high-tech exports from 1.5% to 10% by the year 2016.
- ❖ Identify the factors that hinder the manufacture of hi-tech products out of graphite, such as marketing difficulties and the difficulty of finding other ingredients necessary to produce high-tech products.
- ❖ Finally, find ways and means to discourage raw graphite export for a petty sum and to apply value addition to it to enhance the profits. In addition, study the possibilities available to harness government support for this activity (e.g., Policy changes, tax benefits, etc.)

## PRESENTATIONS AT – A - GLANCE

### Summary of Presentations

The roundtable discussion was initiated with a welcome address and an explanation of objectives by Prof. Ajith De Alwis, Project Director, COSTI.

At the outset he welcomed Prof. Tissa Vitharana, Hon. Senior Minister for Scientific Affairs and the distinguished guests. Stating that COSTI is the brain child of Prof. Tissa Vitharana, he explained the COSTI's responsibility to coordinate and monitor the scientific community and the virtual Institute concept, especially the one on mineral resources and the graphite cluster. He



said that cabinet approval had been obtained on Feb 1<sup>st</sup> 2013, for the establishment of COSTI. While quoting the saying of late Mr. Munidasa Kumaratunga; "The nation which does not do new things will not rise," he stressed the value addition prospect of graphite. He also explained the European Union Flagship Program of graphene by participation of seventeen countries, sixty one universities, and fourteen industries. Then, questioned as to why such a program cannot be established in Sri Lanka. The most valuable point he emphasized is aiming at graphene and beyond in order to manufacture a number of high-tech products which can bring exorbitant profits to the country. As such, if we are successful in graphene there is always the possibility of going beyond.



The speech made by the Prof. Tissa Vitharana, Hon. Senior Minister for Scientific Affairs brought to light many valuable points.

The minister strictly emphasized that Sri Lanka must leave behind its colonial mentality that it was a country destined for the export of raw material for the

British Empire and come up with a new strategy for improving high-tech value addition.

He emphasized that the USA developed economically not because of a large investment, but mainly because of money being allocated to generate science and technology innovation. He further added that even during the economic crisis President Obama minimized the allocations for most other sectors, but increased the investment on science, technology and innovation by 1% of the GDP. He picked South Korea as an example and stated that in seventies a Sri Lanka's poorly developed area was nicknamed "Korea" compared with the downtrodden economy of South Korea that was four times poorer than ours and having poor townships at the time. South Korea had since then achieved immense progress as a result of high-tech value added exports, thus its value-added exports are 70% compared to Sri Lanka's 1.5%. Likewise Japan has 85%, Singapore has 60%, Malaysia has 50% and Thailand 27%. He further mentioned that following the same strategy he was instrumental in establishing SLINTEC as a public-private partnership and now it turns out to be a total success. He also said that we are in the midst of silicon chip age and stepping over to graphene age and need to develop our own graphene. He mentioned the case of brain drain and said that the facilities should be given for scientists to remain here in Sri Lanka rather than joining the brain drain to America. He had been told that in NASA 10% of the scientific community are Sri Lankan. As such, we are helping America to develop. Our human resources going there should be retained, but must make it productive by providing facilities so that our scientists who are second to none to develop the high tech industries that we need. He further added that Sri Lanka is fortunate to have scientists of very high caliber and requested them to carry out research in order to develop hi-tech products so that Sri Lanka can gain more in future rather than exporting raw products at rock-bottom prices. Finally, he requested all the participants to carry out a fruitful discussion to come up with a strategy to gain the maximum benefits from our mineral resources.



Dr. Rohan Fernando, Senior Lecturer from the Open University of Sri Lanka, delivered a valuable presentation relating to graphite formation, exploration and application. He pointed out that price of graphite increases with the increase of its flake size. He also showed that high purity can be expected in larger flake sizes. In addition, he simply explained about the conventional uses of graphite and the basic geology of graphite deposits. He explained current methods practiced locally to achieve the purity enhancement of graphite. He further emphasized the importance of exploration

of graphite especially using modern geophysical methods. Finally, he stressed the importance of further exploration, introduction of graphite based industries to the country and establishing a national mineral policy on value addition.



Mr. Dulip Jayawardena, former director of Geological Survey Department (present GSMB) and State Graphite Corporation delivered a fruitful oration enlightening the audience on very valuable facts relating to the graphite industry, regulatory affairs and future trends.

Even though he presented all these facts without a power point illustration, he could attract the attention of the entire audience primarily due to their importance and validity. He explained the mines and mineral act passed in 1992 and the mineral laws that were prevalent prior to the act. He further explained all the government policies relating to graphite. The local companies were condemned by him for flouting the law by taking advantage of its loopholes and in allowing the foreign companies to take our raw minerals for a song in order to earn a fast buck. He explained further that at present the GSMB is divided into two sections such as mining and geology and the mining section earns an income while the geology section carries out the research. As such, there are differences most of the time; hence it was not a wise move in terms of Sri Lankan mineral resources. Furthermore, a problematic situation was created when the GSMB and Industrial sector were assigned to different line ministries. He also condemned some moves initiated by the BOI without the concurrence of the GSMB in mineral deals and negotiations.

Thereafter, Dr. Dilushan Jayasundara, Senior Scientist, Sri Lanka Institute of Nano Technology (SLINTEC) introduced research related to hi-tech products, especially, graphene. He explained the properties of graphene as a thin, light weight, strong, flexible, transparent, conductive, non-flammable material having a 2D structure.



He further added that during the last several years there was exponential growth of research projects relating to graphene and at the same time exponential growth of research papers and patents relating to graphene. He explained the various synthesis models of graphene and added that high energy cost prevalent in Sri Lanka in a way hinders the industry. He then went on to explain the uses of graphene in modern high-tech industries, especially in military sector and steered the attention of everyone to the tennis rackets used by current Wimbledon champions, which are actually strengthened from carbon nano tubes to provide light weight, strength, durability and the bouncing capability required to have a winning combination in the present world.



Thereafter, Mr. Kalansooriya, Chairman, Kahatagaha Graphite Lanka Limited, delivered his presentation and went into the history of graphite industry of Sri Lanka and then showed the progress achieved by the Kahatagaha mines limited. His slides showed that both the production and sales has increased during the last several years.

He further explained diamond drilling program carried out in different levels of the mine and recent development of the mine, such as addition of the new storage complex, graphite transporting chute, etc. Thereafter, one of his engineers, R & D executive, explained graphite based end products they have experimented with and their effort in building crucibles and graphite bricks together with an explanation as to the pros and cons of construction. The major factor disclosed during this presentation is that in processing products such as crucibles, bricks and carbon brushes, the auxiliary ingredients needed are to be imported from elsewhere incurring a considerable expenditure. As such, the profit margin is negligible if they too compete with the cheap products coming from countries like India and China.



Last presentation of the roundtable discussion was delivered by Dr. Pitawala, Senior Lecturer, University of Peradeniya. He gave an introduction to the ongoing research relating to graphite at the University of Peradeniya. He explained that although China exports 70% of graphite to the world soon its status can change because most of that graphite are extracted from the present mines and developing new mines are very rare.

He too explained the geological and structural setting of Sri Lankan graphite. He further explained the characterization of graphite based on the mineralogy and structure. As such, depending on their character they can be used in different industrial applications. He added that graphite oxides and graphite nano composites too are feasible to produce here and they have diverse uses in a variety of industries. Finally, he emphasized the importance in the participation of scientists of different specialties in projects of this caliber to achieve maximum results, showing the number of papers published and patents applied.

## Summary of Roundtable Panel Discussion

Round table panel discussion was chaired by Dr. Mubarak, Program director, COSTI and the other panelist was Dr. Prashan, Project Scientist, COSTI.



The round table discussion was conducted by having the session separated into several stages each set apart for a topic such as exploration, etc. As such, critical problems were exposed and it was possible to give partial solutions to some of the problems even during the panel discussion itself.

The following questions were raised: Are we fully aware of the extent of our graphite resources? Do we need more exploration? What are the likely areas that could be subjected to through exploration? Do we need research to understand the characterization of our graphite? One suggested that exploration is necessary, but air-borne survey is not that effective as graphite veins show a pinch and swelling structure. As such, in the case of air-borne survey it is difficult to estimate the reserves. Same person added that the best graphite bearing untouched area lies in Vavuniya an area ideal for further exploration for any interested party.

He further added that some mineral bearing land had been used for the construction of hotels because these activities are allowed by the government policies in terms of tourism, land use, policy for farming, etc. Therefore, the mineral policy must overwrite all others in order to get the maximum benefit out of minerals. He further stated that all minerals belong to the state and provinces have no jurisdiction over mineral lands.

One suggested that mining licenses should be issued by those who are conversant in minerals. Sometimes even the Grama Sevaka is involved in this type of duties and a lot of damage could occur due to their lack of knowledge in minerals. Hence, most reputed mining companies, having money, reputation and qualified people, are reluctant to invest in the mining sector. He further said that this country has the best people, but worst procedures.

Another suggested that it should be made compulsory for all mining companies to re-invest some money to promote value addition or to withdraw the mining permit in the case of a failure to do so. Most agreed that such a policy would be ideally suited to enhance the value addition of country's minerals.

The participant from Bogala, praised some of the tax benefits granted by the Sri Lankan Government (Lowest cooperate tax) but condemned the sudden fluctuations in royalties. He also agreed that eventhough the cost of electricity is high in Sri Lanka; it can be compensated with a lower tax.

One who participated from Kahatagha explained that they are mining in the deep, whereas Ragedara is mining in shallow depths. Accordingly, the costs are different for each operation because hoisting for a longer distance involves more money.

One from the University of Moratuwa (UOM) responded that it is time to carry out lateral exploration in working the mines. In view of the fact that most of the mines had already reached the present depth since around fifteen years, and if the depth is increased further the cost too would increase likewise. There is always a possibility to find graphite at low levels, which can be extracted at low cost.

When asked as to how the industry and universities could collaborate in the mining sector, one from the UOM stated that Sri Lanka has the necessary expertise in most areas and most mines and mineral sector industries are run by the UOM graduates. Therefore, there is no difficulty as to the application of technology.

With respect to value addition one from Bogala mines informed that they are producing lubricants out of Bogala graphite and India is willing to buy them. Although India has graphite as well as the technology it cannot produce lubricants like ours because their graphite lacks the characteristic properties of our graphite. He further added that a Japanese buyer is interested in Li-ion batteries and if some researcher is willing to collaborate with either Bogala mine or Kahatagha mine to manufacture them it would be a very valuable project.

One responded by saying that they were already successful in producing Li-ion batteries and would be very happy to join the project and collaborate even in other areas too.

The participant from Bogala, further added that restrictions laid down to import some chemicals (Biocide) necessary to process graphite will also be an obstacle for their work. One from CLINTEC responded by saying that it is possible to export the same chemical under a batch number instead of the brand name. One from the Colombo University promised to give a permanent solution to this problem. In this case, COSTI hopes to collaborate with both parties until a solution is found.

One from Kahatagaha added that the other ingredients necessary to produce value added products from graphite such as alumina, silicon dioxide, magnesium dioxide need to be imported; therefore, value addition is not profitable. One from the University of Peradeniya (UOP) responded by saying that all the material mentioned is freely available in Sri Lanka.

Most participants stated that our electricity is expensive and it is not worthwhile to produce grapheme because it is an energy intensive project. One from John Keels suggested that India is producing the same under a very mild energy condition and the same method could be adapted here.

Finally, most pointed out that unless the policies are fixed very soon and unless the GSMB extends its full support they could not involve in the value addition process.

## RECOMMENDATIONS (ROUNDTABLE DISCUSSION)

1. Establish a straightforward methodology for the issue of licenses (Relating to minerals; Entire licensing procedure should be undertaken by a single organization place like BOI). The responsibility must be handed over to the professionals. As such, GSMB will be the ideal institute. Approaching the “Grama Sevaka” to obtain licenses should be stopped, otherwise a lot of valuable time and money will be wasted.
2. Mineral bearing lands belong solely to the state; these should not be allocated for any other projects such as building hotels, etc. As such mineral policy must overwrite all other policies to safeguard the country’s mineral resources.
3. Maintaining a lower cooperate tax is a very good policy and it should be continued, in addition, sudden changes in policies or royalties must be stopped to encourage the mineral industry.
4. Mineral law should include a clause stating that it is compulsory for all the mining companies to re-invest some percentage of the profit for the research and development leading to value addition and finally to come up with value added products.
5. There has to be some strategy to provide electricity at a subsidized rate for those who could prove that they are making value added products using most of Sri Lankan raw minerals.
6. The restrictions laid down to import some chemicals (e.g., Biocide) necessary to process minerals must be removed, provided these chemicals are to be used exclusively in the mineral industry (not any other industry).
7. Government must fix the current policies to attract reputed mineral companies and also must grant tax benefits for the value added mineral industries.
8. COSTI must act as the mediator as well as the facilitator to form a link between researchers, industry and the government agencies in order to promote the value addition process of country’s minerals.
9. COSTI must launch its novel concept titled “Virtual institute” among the stakeholders involved in the mineral sector and must form a virtual connectivity at all times. As such, virtual Institute must provide answers to the current problems that exist in the mineral sector, once its network is established among professionals.

## ANNEX I : DERAILS OF PARTICIPANTS

### Invitees

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