Indicators [www.esi-topics.com], and Gupta has not mentioned the years right. According to Gupta, all the data on number of papers and average citations per paper pertain to the period 1991–2000. In reality though only three sets of data (nanotechnology, quantum cryptography and conducting polymers) pertain to this period; the data for optoelectronics pertain to 1991–99; the data for neutrinos, photonics, quantum dots and magnesium diboride pertain to 1992–2002; the data for molecular self-assembly pertain to 1991–2001, and the data for fuel cells pertain to 1993–2003. Also, Gupta uses the term 'impact factor' for the nation as a whole although the term is used only for journals. Gupta says that for Indian papers citations per paper have gone up from 1.15 in 1992 to 1.6 in 2002, but does not say citations in how many years. Unfortunately, such casual use of numbers without a good understanding of what they mean or refer to is increasingly becoming common in India. But I would expect someone assisting the Principal Scientific Adviser to the Cabinet to report data accurately, use technical terms (such as impact factor) with care, and provide bibliographic references correctly.

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SUBBIAH ARUNACHALAM

M.S. Swaminathan Research Foundation, Chennai 600 113, India
e-mail: arun@mssrf.res.in

COMMENTARY

Marine gas hydrates: their economic and environmental importance

Anil K. Gupta

With increasing energy demand and depleting energy resources, gas hydrates may serve as a potentially important resource of future energy requirements. The conditions suitable for the occurrence of gas hydrate exist in a few hundred metres of the rapidly accumulating continental margin organic-rich sediments[1]. Methane is formed from the microbiological decay of organic matter in the absence of oxygen and can also be of thermogenic origin. The gas hydrate study was started in 1778 (by Priestly), whereas the chemistry of gas hydrates was discovered in the early 19th century, when in 1810, Humphrey Davy found that ice-like crystals were formed when the aqueous solution was cooled[2]. The interest in gas hydrate research has increased steadily since 1965, when gas hydrate deposits were first reported in the Soviet Union[3]. The intensive exploration activity undertaken by the oceanographers and petroleum geologists during the last decade, facilitated widespread occurrence of gas hydrates in the continental margin areas.

Importance of gas hydrates

It has become increasingly evident that naturally occurring gas hydrates are important components of the shallow geosphere and are of societal concern in at least three major ways: resource, hazard and climate[1]. Two reasons make gas hydrates attractive as a potential resource. First is the enormous amount of methane that is apparently sequestered within clathrate structures at shallow sediment depths within 2000 m of the earth's surface. Second is the wide geographical distribution of the gas hydrates. It was mentioned that the energy potential of methane hydrates is considerably greater than that of the other unconventional sources of gas, such as coal beds, tight sands, black shales, deep aquifers and conventional natural gas[4]. The resource potential of marine gas hydrate is yet to be ascertained, but considering the possibility of enormous gas reservoirs, gas hydrates will continue to attract attention until their development potential is measured.

Role in continental margin sediment instability

If large volumes of methane are stored in marine reservoirs, they may significantly influence the sedimentary environment in which they occur. The formation and subsequent decomposition of gas hydrates within the sediments affect the physical properties of the sediment as well. Changes in pressure and temperature will decompose solid gas hydrates to gas and water, which may lead to sediment instability and failure.

Environmental impact

It is assumed that the release of methane from marine hydrates during climatic maxima and minima has played a significant role in climate change. The earth has witnessed several intervals of climate change, typified by lowering and rise in sea level due to rapid cooling and warming. Because several of these time intervals are characterized by major inputs of carbon to the ocean and atmosphere, and because the change in pressure–temperature conditions during these time slices may have reduced the stability of gas hydrate reservoirs, it is believed that the release of methane from marine hydrates has played a significant role in warming the earth's climate. During glaciation when the sea-level drops, large volumes of methane may be released; conversely, when the sea level rises, the lower limit of gas hydrate stability migrates downward and may trap more gas. Sea-level-controlled methane releases could act as a negative feedback to advancing glaciation by producing global warming and as a positive feedback during sea-level rise.

Exploration of gas hydrates

The extent of worldwide gas hydrate occurrences has been evaluated using seismic exploration, because gas hydrates are characterized by the occurrence of an anomalous reflector parallel to the sea floor (bottom simulating reflector, BSR). But BSRs have failed to locate gas hydrate horizons in a few cases, e.g. at Ocean Drilling Program Site 994C located on the Blake Ridge, North Atlantic, where much information comes from the geochemical and sediment parameters[5]. Besides, microfaunal groups like benthic foraminifera can also provide useful information for locating the gas hydrate horizons. Some species of benthic foraminifera colonize hydrocarbon-seeped bacterial mats and may be attracted to methane gas or hydrogen sulphide gas emissions.

Greater need for multi-institutional efforts to explore gas hydrates

Gas hydrates trapped in the marine sediments require multifaceted, extensive efforts to bring them into world energy balance. Government organizations, laboratories and oil industry have recently taken up projects to explore gas hydrates in the Indian offshore areas. However, participation from the academic institutions is negligible due to lack of collaboration among them. There should be greater involvement of researchers from academic institutions to intensify efforts in the exploration of gas hydrate horizons. Besides, the country needs more sophisticated drilling vessels with deep penetration drilling devices and a repository to store sediment cores.

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Anil K. Gupta is in the Department of Geology and Geophysics, Indian Institute of Technology, Kharagpur 721 302, India. e-mail: anilg@gg.iitkgp.ernet.in