continental lithosphere under compression require either unrealistically large initial applied stresses or very high heat flow to result in *whole lithosphere failure* causing geologically significant strains[6]. While the large initial stresses during the breakup of Pangaea may be difficult to explain, a hotter Indian lithosphere during late Cretaceous and early Tertiary[7] may have met the necessary conditions required to cause whole lithosphere failure. We lack independent estimates of strain in the continental Indian plate to test this hypothesis. The deep seismic sounding profiles that can constrain the rheological state of lithosphere in this area are very few and far between.

Future experiments to estimate the rates of deformation using arrays of global positioning system (GPS) receivers, and to constrain the rheological state of the Indian continental lithosphere using state-of-the-art controlled source seismology will lead to a better understanding of the intraplate earthquakes of the Indian shield *vis-à-vis* theory of plate tectonics. Furthermore, such experiments have a great potential for characterizing the hidden fault zones.

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What should India be doing in the human genome?

S. S. Agarwal

If there can be genuine differences of opinion on the subject of human genome research between elite scientists the world over, how can India be an exception? And if there is a difference of opinion and it is not expressed, how can one expect a mature decision? This is what has motivated me to pen down my thoughts as a rejoinder to the views expressed by J. Gowrishankar in his erudite article on the subject which appeared in *Current Science*, 1993, **64**, 705. I do not think there can be any difference of opinion on the need and utility of research on human genome as conceded by Gowrishankar himself. The real difference is in the approach. One school of thought would like it to be pursued in mission mode while the other would like it to be supported through standard individually initiated peer reviewed mechanisms as has been suggested by Gowrishankar. This debate is the same, whether it is India or United States. The interested reader is referred to a series of articles that appeared in the January 1991 issue of the journal FASEB. But what may be applicable to US may not be applicable to India and so the question still remains what should India be doing? We have to admit that there is severe resource constraint in India. More important than financial crunch is the human resource crunch. There is very little critical mass in most fields. Another limiting factor in front-line research is dependence on imported equipment and chemicals. Under these circumstances we have to heavily weigh the chances of success even if we start in mission mode. However, there are several positive indicators as well. One is that our scientists have the advantage of English as a medium of education They are well informed about the developments in the field. The second is that the nation has recognized long ago that biotechnology is the need of the hour and considerable infrastructure has been built in this direction in the country over the last 10–15 years. What is missing is the participation of medical men and women and a mission and zeal that is required to accomplish a task. It is both because of lack of appreciation and commitment as well as lack of inputs. What is more important to be decided is the cost-effectiveness of the approach rather than the fear of funding poor quality research under mission mode.

It does not require any clairvoyance to visualize the importance of possessing the knowledge of the human genome. The talk of patenting the human genome and TRIPS is not trivial. In this context the words of the President of ASSOCHAM are worth reminding. He has very succintly said that if we keep on importing technology a day may come when we may not have it even if we have the money to pay for it. The recent episode of cryogenic rockets is a good pointer in this direction. One laudable step of the GOI has been to be watchful of the future interests of the country in its Antarctica mission. Likewise, the investment in human genome is for the 21st century. A decision to remain out of the pursuit of human genome must be carefully debated.

Now coming to the question of cost effectiveness. To my mind there is nothing more frustrating than a half-hearted approach. It is a peculiar syndrome of a developing country like India that we would like to do it but cannot muster sufficient courage and will to do it. It is true that this may be related to our financial difficulties. But even the more affluent countries have their financial constraints. We have to decide about our investment which can pay in future. The direction of research takes a long time to develop and is determined by funds. Support for research on cancer and AIDS in US are prime examples. It is only when sustained funding is assured that researchers take that direction. The mission mode cannot bring overnight accomplishments Mission mode is not to waste funds or to make miracles It is only a reflection of will and commitment. There can be no two opinions that there should be no compromise with the quality of research. The role of peer review in mission mode should not at all be relaxed. However, it would certainly mean assured funds in a given direction if there are takers. It has to be realized that many activities required for the success of a programme may not be research questions per se. Funding of such activities is crucial for questions to be answered. This can only be possible in the mission mode. The mission mode is not a reservation or protection. It is a commitment, an encouragement, or even an inducement.

What is important is to ask what India can contribute to HGR effort. What are likely to be the fallouts and the by-products of such an effort? One would have to identify or create groups and nurture them. An environment will have to be created to bring out an interaction between these groups. All this would need to be done at a speed that is commensurate with the rest of the world. A central organization with effective communication is necessary for such a venture. This can only be possible in a mission mode, whether it be in the form of a separate PAC or a unit or an agency. However, if investment in HGR effort is not in national interest then it is a different matter altogether.

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TECHNICAL NOTES

Augmented Satellite Launch Vehicle (ASLV)

M. B. Reddy and M. S. R. Dev

The launching of ASLV-D3 at 0600 hrs on 20 May 1992 preceded by a flawless countdown, resulting in the successful injection of SROSS into low earth orbit is a major milestone for the Indian Satellite launch vehicle development programme. ASLV project was designed as a low-cost launch vehicle for highly complex technologies which is incorporated in the polar satellite launch vehicle (PSLV) and geostationary satellite launch vehicle (GSLV) and to launch 150 kg class payloads into low earth orbit. The development of complex technologies such as canted nozzle, bulbous metallic heatshield, design and fabrication of strapon motors, achieving and demonstrating the differential thrust requirement between strap-on motors and closed loop guidance system were primary objectives. A new concept of integration had to be evolved resulting in the design and building of a new launch pad with mobile service structure for ease of vehicle integration. ASLV is configured as a five-stage solid propellant vehicle weighing 40 tonnes and a length of 23.8 m. The total flight time of the mission was about 500 s.

Design considerations

Configuration

During configuration finalization of ASLV, certain guidelines like utilization of proven technologies, realizing the launch at a reasonable cost and schedule were considered. In addition, ASLV was identified as a base line vehicle for proving some of the technologies required for future generation launch vehicles of ISRO and to use this launcher for space science and application missions. Hence ASLV was configured (i) to maximally utilize ISRO's first launch vehicle SLV-3 systems to retain the heritage, (ii) to develop and qualify technologies in the areas of strap-ons, close loop guidance, bulbous metallic heat shield, vertical integration etc. required for future launch vehicles.

ASLV is a five-stage rocket with all the stages having solid propellants. It has a gross lift-off mass of 41.8 t and an overall length of 23.852 m. The configuration of ASLV shown in Figure 1 has the following features.

Two strap-on boosters (ASO) (1 m dia and 10 m long) having total weight of 11.60 t each and nozzles with 9° cant constitute zeroth stage. First stage (AS1) with similar dimensions had a total weight of 11.7 t. As in the case of ASO and AS1, the second stage (AS2) booster case was loaded with hydroxy terminated poly butadine (HTPB)-based propellant in the 'star' shape for radial burning. AS2 with a total weight of 4.4 t was 6.3 m long and 0 8 m in dia. The third and fourth stage motors were loaded with high energy fuel code named HEF-20 and slotted con-