On the probable existence of life on Mars

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In the quest for spotting existence of life in the universe, the possibility of life on Mars and on any one of the moons of outer planets, continues to be debated. Some indirect evidence of existence of life on Mars has been discussed. New clues about existence of water on Mars include the Martian meteorites received on the earth's surface depicting enrichment of D/H ratio in the Martian atmosphere. It was shown that the Martian crust had enough water to form a global surface layer 500 m thick or even greater, as discussed by Jakosky and Jones[1]. The samples of Martian meteorites collected on the earth's surface have been analysed and a high concentration of sulphur has been found[2]. The distinctive fingerprint of Martian atmospheric chemistry was found in the samples of meteorites collected from different parts of the earth's surface[3]. The presence of sulphur on the Martian surface has far-reaching implications regarding the existence of life. The geological and biological processes separate isotopes according to their masses and the resulting 'fractionations' are significantly changed in the process of oxidation. It is well known that sulphate-respiring bacteria on earth reduce sulphur and in this process produce relatively large fractionations between ^{32}S and ^{34}S samples, as discussed by Nielsen[4]. The analyses of SNC meteorite samples depicted that the early Martian interior was hot and the interior of Mars was active. The thermal gradient of 0.18 to 0.36 km^{-1} billion years ago is reduced to 0.03 to 0.06 km^{-1} at present[5].

The Martian maps show hot southern hemisphere of Mars with heavily cratered highlands that represent the ancient crust of Mars. The Mars pathfinder, alpha proton X-ray spectrometer (APXS), has measured the elemental composition of rock samples. The APXS analysis has concluded that the Martian rocks are evolved silica- and alumina-rich igneous rocks similar to 'andesites' found on the earth's surface[6,7]. Another important rock sample is the Allen Hills–84001, which is roughly 4500 million years old and is believed to be coming from the southern highlands of Mars. Some of these meteorite samples are 1300 million years old or even younger[7].

In 1972, the Mariner-9 Orbiter photographed the surface of Mars, showing signs of giant flood channels and arbrescent networks of small valleys which provided evidence for the presence and flow of water on the surface of Mars[8–12]. These observations were supported and confirmed by analyses of Mars 4 and 5 and of Viking Orbiter images. In recent years many of the Mars-bound missions have failed because of one kind of lapse or the other. The NASA reviewed the situation and decided to go slow, to gain confidence. However, Mars Global Surveyor (MGS) launched on 12 September 1997 started mapping the Mars surface in March 1999. The Mars Orbiter Camera (MOC) scanned and recorded pictures of the Martian surface. The MOC data analyses showed evidence of flow of water on the Martian surface and provided high-resolution images (2 to 8 m/pixel) that indicate authentic occurrence of seepage-fed surface run-off. The evidence of Martian water flow was detailed by Malin and Edgett[13] and they argued that the Martian landforms are of relatively recent origin and could even be of contemporary origin. The results of MGS have been encouraging and details of the Martian surface are shown to be liveable for human beings.

During its limited life of active survey the MGS has created sensation in the realm of planetary science investigators. The reporting in *Science* by Kerr[14] and a detailed paper by Malin and Edgett[13] went a step further and created 'a wave of chatter about water and therefore the existence of possible life on Mars'. The evidence for water flowing on the surface of Mars comes from Malin's high-resolution camera orbiting the planet aboard MGS for about two years. In about 200 of the 65,000 images returned so far, Malin and Edgett have found places from where water appears to have emerged through the crater wall or valley side. Alternative explanations have also been put forward by scientists, which oppose[14] the findings and assertions of Malin and Edgett[13]. The detailed discussion of water on Mars has excited the scientific community at large. Signs of near-surface water, whether liquid, solid or clatherates, is an important result. A subsequent assertion was made: 'it is not just spring-life seeps, but young lava flows, salty meteorites and unblemished water channels that are making the Red Planet look alive again'. These features clearly show 'Water and younger Mars emerging' as detailed by Squyres and Kasting[5], and recently by Kerr[14]. As pointed by Kerr, the MOC camera onboard MGS is providing unprecedented details of the Martian surface. Its high-resolution images come in strips of just three kilometres wide that cover only about 1% of the planet. Thus we find that many details of the Martian surface features are yet to be resolved. Some of these details would become available by sending human beings on Mars and collecting samples from the Martian surface.

In USA, the scientific community, at the national level, has decided 'to go slow and carry out experiments with smaller probing systems' before planning to make *in situ* exploration to study Martian atmosphere and surface, with a view to settle the question of probable life on Mars[13–16]. The debate on probable existence of life on other planets has gone beyond the surroundings of the earth in our solar system. Probability of life on outer planets and their moons is also being debated but so far, the scientific community has not encountered any *definite* proof of existence of life anywhere else in the universe. The global scientific community is engaged in providing definite answers to existence of life in the universe.

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FROM THE ARCHIVES

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Science and society

Ever since men began to live in organised society, in which the law of the jungle was replaced by tradition and custom, there has been speculation as to the past and the future of humanity. There have been those who placed the golden age in the dim past and looked upon the successive stages of human history as years of decay and decline; others have visualised changes in society as cyclic in character; but the idea of progress which has dominated recent social thought is a child of the later eighteenth century, and it was the hope of the unlimited progress of humanity, which illumined the age of Reason in the later eighteenth century. Condorcet spoke of a 'science of man', but it was left to others like Comte and Spencer to work out in detail a science of society, which has come to be known as Sociology, whose 'laws' gave the earlier dreams of progress a body and a direction. Under the influence of the great changes of the Industrial Revolution, these early students of sociology conceived of humanity as moving towards a state of things in which industrialism would be the dominant note, and peace among mankind and goodwill towards all would prevail.

This progress was not supposed to prevail among all sections of humanity, nor was it continuous; many believed with Leslie Stephen that 'Progress is the rare exception; races may remain in the lowest barbarism or their development be arrested at some more advanced stage; actual decay may alternate with progress, and even true progress implies some admixture of decay'. The early years of the twentieth century seemed to deepen the note of interrogation, and the check to the industrial progress of some of the European countries, the rise of Japan, and the uneasy stirrings in their age-long sleep of other Eastern nations roused the apprehensions of Europe. Accordingly more than a quarter of a century ago, Mr Balfour examined the possibilities of decadence among the advanced nations of Europe and the chances of advance into the vanguard of progress by Oriental peoples, who were till then believed to be static. Mr Balfour ruled out the latter possibility, holding that 'progress is with the West; with communities of the European type'. He was of opinion that the progressive character of the nations of the West would be supported and reinforced by the social force that had come into being, 'new in magnitude if not in kind, viz. the modern alliance between pure science and industry'. We have been told how fruitful that alliance has been by Mr Keynes in his striking description of the 'extraordinary episode in the economic progress of man constituted by the age which came to an end in August 1914'.

Science had no doubt done wonders for the economic progress of men, but the same date that closed the epoch of economic munificence also opened a devastating episode in the history of man, in which science armed man with weapons of terrific capacity for destruction. The War in which thousands of millions of capital and millions of human lives were destroyed was followed by a short period of seeming prosperity and settlement. Then came the great Depression, which revealed another aspect of science in relation to society. Mankind has been living since 1929 in the shadow of this great economic catastrophe, lacking employment and food, not because the bounty of nature has been exhausted nor because science has come to a stop in its progressive control of natural forces, but entirely because social organisation has proved itself incapable of adjustment to the new discoveries of science, which, it has been proclaimed on all sides, has placed abundance beyond dreams for the first time within the reach of mankind. Man has stood helpless, hungry and cold, before the plenty that science has produced for him. Coffee has been thrown into the sea, wheat has been burnt in furnaces, and pigs have been slaughtered by the million, and mankind is starving. . . .

It is clear that scientific discoveries have outrun man's mental and moral capacities, and we are yet a long way from the realisation of the dream of Condorcet, of 'the human race freed from all its fetters, withdrawn from the empire of chance, as from that of the enemies of progress and walking with firm and assured steps in the way of truth and virtue and happiness'. For a double problem is set to humanity by the progress of science: smooth articulation of scientific discovery with the complex machinery of social life, and the use for human advancement, and not for human destruction, of the increased control over nature that science has been placing in our hands.