James Hutton

The Father of Modern Geology

Recently, through the kind courtesy of Prof. K.V. Subbarao of IIT Bombay, I had an opportunity of re-reading the classic work of Archibald Geikie – 'The Founders of Geology.' This book, as well as its companion volume "A Long Life's Work", were the two books which I had the good fortune to study as a student in 1934 when I stepped into the Geology Department of Central College and had free access to its well-stocked library.

I was greatly impressed with the style of writing of Archibald Geikie, the author of the famous Textbook of Geology which had inspired generations of students in the comparatively new discipline of geology. My father was a great admirer of Geikie and, seeing his favourite books on my table took them away to read and became totally absorbed in their study. I saw him making copious notes, copying passages of what appealed to him as passages of extraordinary beauty. Reading again these texts after a lapse of nearly seventy years has been a rewarding experience and I would like to share my delight with the readers of our journal.

In the modern democratic set-up, one must be for ever shouting and extolling his own virtues. If he fails to do so he soon becomes a back number. The truly great, however, are little fitted to practice self-aggrandisement with the result their works and pioneering efforts remain largely forgotten. Special efforts are necessary in recognizing their greatness and the importance of their contributions.

Geikie in these books tells us of the story of the great pioneers of our science, of their struggles, their failures and their successes and tracing how geological ideas and theories first arose and assumed their present form. I shall confine myself in this essay to the contribution of one individual, James Hutton (1726-1797), whose work '*Theory of the Earth*', according to Geikie, 'will ever remain one of the great classics of science'.

James Hutton was born in Edinburgh on 3rd June, 1726. Very early in life he developed a fondness 'of studying the surface of the earth, and looking with anxious curiosity at every pit or ditch or bed of a river that fell in his way.' Most of the time he was absorbed in meditating on some of the profoundest problems in the history of the earth and spent his life gathering materials to be able to find a solution to these problems, an exercise never before attempted.

Hutton is pictured as having a high forehead, firmly moulded features, keen observant eyes, and a well-shaped, rather aquiline nose, which marked him at once as a man of strong intellect while the gentleness that beamed on his face was a reflection of the kindness of his nature. His plain dress, all of one colour, gave further indication of the unostentatious simplicity of his character.

He was no narrow specialist wrapped up in the pursuit of one circumscribed section of human enquiry. 'His mind ranged far and wide over many departments of knowledge.' The scenery around the city of Edinburgh stimulated him, giving form and colour to the development of his theory. 'If he turned eastward, Arthur's Seat and Salisbury Crags rose in front of him, with their memorials of ancient volcanic eruptions. If he strolled westward, the ravines of the Water of Leith presented him with proofs of the erosive power of running water..... Even within the walls of the city, the precipitous Castle Rock bore witness to the energy with which in ancient times molten material had been thrust into the crust of the earth.'

'For about thirty years he had never ceased to study the natural history of the globe, constantly seeking to recognise the proofs of ancient terrestrial revolutions and to learn by what causes they had been produced. He had been led to form a definite theory or system which, by uniting and connecting the scattered facts, furnished an intelligible explanation of them.'

The founding of the Royal Society of Edinburgh in 1783 made him communicate a concise account of his theory which was later expanded under the title

'Theory of the Earth with Proofs and Illustrations.' After Hutton's death, his friend Playfair published, in 1802, his popular book 'Illustrations of the Huttonian Theory.' One of the fundamental doctrines of Hutton's system was that the internal heat of the globe in the past is evidenced by the intrusions of large masses of molten material in the crust.

This essay which he presented before the Royal Society of Edinburgh marked the turning point in the history of geology but it remained without attracting notice from friend and foe for several years. This was probably due to the terseness of his style and also because it appeared in the *Transactions* of a Society which had only recently been founded, and whose publications were hardly yet known to the general world of science.

Hutton's friend, John Playfair, was a famous mathematician 'gifted with clear penetrating mind, a rare faculty of orderly logical arrangement, and an English style of altogether remarkable precision and elegance.' Commenting on the writing of Playfair, Geikie says:

> 'For precision of statement and felicity of language it has no superior in English scientific literature. To its early inspiration I owe a debt which I can never fully repay. Upon every young student of geology, I would impress the advantage of reading and re-reading and reading yet again this consummate masterpiece.'

The dominant idea behind the theory of the earth propounded by Hutton was the grand conception that the past history of the globe must be explained by what can be seen to be happening now, leading to the axiom – *the present is the key to the past.* We are quite familiar with this principle which is the corner stone of modern geology. It was the genius of Hutton which grasped this truth with unerring insight. He was the first to notice strata disposed in orderly arrangement, parallel with each other and that strata were composed of detrital material derived from rocks older than themselves, in the same way as sediments accumulating under the sea at the present day. Further, these strata, wherever he observed them, had lost their gently inclined position and had become stupendously contorted and ruptured. Hutton argued that this character had to be attributed to great convulsions, which from time to time had shaken the very foundation of the earth.

Although these ideas appear as commonplace observations familiar to most people today, the credit for observing and grouping them into a coherent system by which 'the earth became as it were, her own interpreter' should go to Hutton.

Huttonian theory presented a new view of the origin of granite, which formed the basement for all known rocks. He believed it to be younger than the strata which rested upon it, as it showed signs of melting and was intrusive into the overlying strata. This view was opposed to the prevailing dogma of Werner who regarded granite as an aqueous formation, a first precipitate that accumulated at the bottom of a primitive universal ocean. Hutton's important contribution was to demonstrate, on the basis of numerous arguments, the intrusive character and igneous origin of granite.

We have to go back to Hutton to realize the important role played by weathering in the processes operating on earth. From mountain top to sea-shore, wherever we may go, he pointed out, each variety of rock, in every kind of climate, is doomed to disintegrate, being subjected to the destructive power of chemical and mechanical agents. No rock, however hard it may be, could escape this relentless weathering process. This most important generalization of Hutton, the potency of denudation in the production of the topography of the land is beautifully summarized by Playfair.

> "Every river appears to consist of a main trunk, fed from a variety of branches, each running in a valley proportioned to its size, and all of them together forming a system of valleys, communicating with one another, and having such a nice adjustment of their declivities, that none of them join the principal valley, either on too high or too low a level, a circumstance which would be infinitely improbable if each of these valleys were not the work of the stream that flows in it."
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> '....when the usual form of river is considered, the trunk dividing into many branches which rise at a great distance from one another, and these again subdivided into an infinity of smaller ramifications, it becomes increasingly impressed upon the mind that all these channels have been cut by the waters themselves; that they have been slowly dug out by the washing and

> erosion of the land; and that it is by the repeated touches of the same instrument that this curious assemblage of lines has been engraved so deeply on the surface of the globe.'

The entire modern doctrine of earth-sculpture is to be found in the Huttonian theory – views now accepted without question, but which were ignored or even rejected wholly when first put forward. Rocks get weathered to form sediment which gets buried. After burial they undergo metamorphism. Later they are deformed and uplifted to form mountain chains only to get weathered again and recycled. In this process there is *no vestige of a beginning nor prospects of an end.* The operation of this grand geological cycle was enunciated by Hutton 200 years ago!

Playfair sums up the essence of Huttonian theory in a superb manner:

> . . . It is the particular excellence of the theory, that it ascribes to the phenomena of geology, an order familiar to that which exists in the processes of nature with which we are best acquainted, that it produces seas and continents not by accident but by the operation of regular and uniform causes, that it makes the decay of one part subservient to the restoration of another and gives stability to the whole, not perpetuating individuals, but by reproducing them in succession.'

The beauty of the doctrine of Hutton is that there are no assumptions in his theory. Every principle he enumerated was based on observation and 'every step in his deductions was based upon actual fact and the facts were so arranged as to yield naturally and inevitably the conclusions he drew from them. In the interpretation of Nature, he made it clear, that no powers are to be employed that are not natural to the globe, no action to be admitted except those of which we know the principle, and no extraordinary events to be alleged in order to explain a common appearance.'

Hutton seems to have been a very fortunate person. 'No geologist' Geikie says 'ever lived among a more congenial and helpful group of friends than Hutton. While they had a profound respect for his genius, they were drawn towards him by his winning personality and he became the centre for all that was bright, vivacious and cheerful in that remarkable circle of eminent men.' He discussed his theory with them and their approval was ample enough for his ambition. He was a man absorbed in the investigation of Nature, to whom personal renown was a matter of utter indifference, contented and happy in the warm regard and sympathetic appreciation of the friends whom he loved.'

Such was the remarkable personality of Hutton and geologists of the present-day should take him as a model. They should develop a love for nature and a keen sense of observation, cultivate the friendship of men of real ability who are willing to share their experience and knowledge, not for personal advancement but for the pleasure of sharing knowledge with others.

It will be appropriate to conclude this note with the call given by Geikie, uttered nearly a hundred years ago but which remains true even today.

> '....Geology now possesses a large and ever-growing body of well-ascertained fact, which will be destroyed by no discovery of the future, though it will doubtless be vastly augmented, while new light may be cast on many parts of it now supposed to be thoroughly known.....'
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> 'Each of us has it in his power to add to this accumulation of knowledge. Careful and accurate observation is always welcome, and may eventually prove of signal importance. While availing ourselves freely of the use of hypothesis as an aid in ascertaining the connection and significance of facts, we must be ever on our guard against premature speculation and theory, clearly distinguishing between what is fact and what may be our own gloss or interpretation of it. Above all, let us preserve the modesty of the true student, face to face with the mysteries of Nature. Proving all things and holding fast that which we believe to be true, let us look back with gratitude and pride to what has been achieved by our forerunners in the race, and while we labour to emulate their devotion, let us hold high the torch of science, and pass it on bright and burning to those who shall receive it from our hands.' (Geikie, 1897)

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