**ISOSTASY**

**1**. **Theory of Sir George Airy:**

According to Airy the inner part of the moun­tains cannot be hollow; rather the excess weight of the mountains is compensated (balanced) by lighter mate­rials below. According to him the crust of relatively lighter material is floating in the substratum of denser material. In other words, ‘sial’ is floating in ‘sima’.

Thus, the Himalayas are floating in denser glassy magma. According to Airy ‘the great mass of the Himalayas was not only a surface phenomenon – the lighter rocks of which they are composed do not merely rest on the level surface of denser material beneath, but, as a boat in water, sink into the denser material’.

In other words, the Hima­layas are floating in the denser magma with their maximum portion sunk in the magma in the same way as a boat floats in water with its maximum part sunk in the water. This concept in fact involves the principle to floation. For example, an iceberg floats in water in such a way that for every one part to be above water level, nine parts of the iceberg remain below water level. If we assume the average density of the crust and the substratum to be 2.67 and 3.0 respectively, for every one part of the crust to remain above the substra­tum, nine parts of the crust must be in the substratum. In other words, the law of floatation demands that ‘the ratio of freeboard to draught is 1 to 9.’ It may be pointed out that Airy did not mention the example of the floation of iceberg. He simply maintained that the crustal parts (landmasses) were floating, like a boat, in the magma of the substratum.

It we apply the law of floatation, as stated above, in the case of the concept of Airy, then we have to assume that for the 8848m height of the Himalaya there must be a root, 9 times more in length than the height of the Himalaya, in the substratum. Thus, for 8848 m part of the Himalaya above, there must be downward projection of lighter material beneath the mountain reaching a depth of 79,632m (roughly 80,000 m). Joly applied the principle of floation for the crust of the earth taking the freeboard to draught ratio as 1 to 8. According to him ‘for every emergent part of the crust above the upper level of the substratum there are eight parts submerged’. If we apply Joly’s view of floation to the concept of Airy, there would be downward projection of the Himalaya upto a depth of 70,784m (8848m x 8) in the substratum

Thus, according to Airy the Himalayas were exerting their real attractional force because there existed a long root of lighter material in the substratum which compensated the material above. Based on above observation Airy postulated that ‘if the land column above the substratum is larger, its greater part would be submerged in the substratum and if the land column is lower, its smaller part would be submerged in the substratum.’

According to Airy the density of different columns of the land (e.g. mountains, plateaux, plains etc.) remains the same. In other words, density does not change with depth, that is, ‘uniform density with vary­ing thickness.’

This means that the continents are made of rocks having uniform density but their thickness or length varies from place to place. In order to prove this concept Airy took several pieces of iron of varying lengths and put them in a basin full of mercury. These pieces of iron sunk upto varying depths depending on their lengths. The same pattern may be demonstrated by taking wooden pieces of varying lengths. If put into the basin of water these would sink in the water according to their lengths (fig. 6.1).

**Illustration of The Concept of Airy on Isostasy**

Though the concept of Sir George Airy com­mands great respect among the scientific community but it also suffers from certain defects and errors. If we accept the Airy’s views of isostasy, then every up­standing part must have a root below in accordance with its height.

Thus, the Himalayas would have a root equivalent to 79,632m (if we accept the freeboard to draught ratio as 1 to 9) or 70,784m (if the freeboard to draught ratio is taken as 1 to 8). It would be wrong to assume that the Himalaya would have a downward projection of root of lighter material beneath the moun­tain reaching such a great depth of 79,634m or 70,784m because such a long root, even if accepted, would melt due to very high temperature prevailing there, as tem­perature increases with increasing depth at the rate of 1°c per 32m. “Quite recently, however, the fundamental con­cept of Airy, the continental masses floating as lighter (sial) blocks in a heavier (sima) substratum, has been rejuvenated, largely through the influence of Heiskanen’s work, so that is now probably true to say that most geologists favour Airy’s explanation’.

**2. Theory of Archdeacon Pratt:**

While studying the difference of gravitational deflection of 5.236 seconds during the geodetic survey of Kaliana and Kalianpur Archdeacon Pratt calculated the gravitational force of the Himalaya after taking the average density of the Himalaya as 2.75 and came to know that the difference should have been 15.885 seconds. He, then, studied the rocks (and their densi­ties) of the Himalaya and neighbouring plains and found that the density of each higher part is less than a lower part. In other words, the density of mountains is less than the density of plateaux, that of plateau is less than the density of plain and the density of plain is less than the density of oceanic floor and so on. This means that there is inverse relationship between the height of the reliefs and density. According to Pratt there is a level of compensa­tion above which there is variation in the density of different columns of land but there is no change in density below this level. Density does not change within one column but it changes from one column to other columns above the level of compensation.

Thus, the central theme of the concept of Pratt on isostasy may be expressed as ‘uniform depth with varying den­sity’. According to Pratt equal surface area must under­lie equal mass along the line of compensation. This statement may be explained with an example (fig. 6.2).

Line of Compensation According to Archdeacon Pratt

There are two columns, A and B, along the line of compensation. Both the columns, A and B, have equal surface area but there is difference in their height. Both the columns must have equal mass along the line of compensation, so the density of column A should be less than the density of column B so that the weight of both the columns become equal along the line of compensation.

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Thus, Pratt’s concept of inverse relationship between the height of different columns and their respective densities may be ex­pressed in the following manner- ‘bigger the column lesser the density and smaller the column, greater the density.’ According to Pratt density varies only in the lithosphere and not in the pyrosphere and barysphere.

Thus, Pratt’s concept of isostasy was related to the ‘law of compensation’ and not to ‘the law of floatation.’ According to Pratt different relief features are standing only because of the fact that their respective mass is equal along the line of compensation because of their varying densities. This concept may be explained with the help of an example .

**Explanation of The Concept of Prat on Isostasy**

Bowie has opined that though Pratt does not believe in the law of floatation, as stated by Sir George Airy but if we look, minutely, into the concept of Pratt we certainly find the glimpse of law of floatation indirectly. Similarly, though Pratt does not believe directly in the concept of ‘root formation’ but very close perusal of his concept on isostasy, does indicate the glimpse of such idea (root formation) indirectly.While making a comparative analysis of the views of Airy and Pratt on isostasy Bowie has observed that ‘the fundamental difference between Airy’s and Pratt’s views is that the former postulated a uniform density with varying thickness, and the latter a uniform depth with varying density. Fig. 6.4 explains the fundamen­tal difference between the concepts of Airy and Pratt on isostasy.

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