ISOSTASY

⟹ **Introduction** → The term ISOSTASY is derived from "ISOSTASIOS", a word of Greek language meaning the state of being in balance or equal Standing. Thus, "Isostasy simply means a Mechanical (or Physical) Stability between the upstanding parts and lowlying basins on a rotating earth".

⟹ **Why do we study Isostasy** → * It is invoked to explain how different topographic (Landform) heights (Mountains, plateaus, Ridges etc.) can exists on the Earth's surface.

* Isostatic equilibrium is an ideal state where the crust and Mantle would settle into in absence of disturbing forces. These are the examples of processes that perturb (अवरुद्ध) isostasy →
  - The waxing & waning (आर-पार) of ice sheets,
  - Erosion, Sedimentation, &
  - Extrusive Volcanism.

* The physical properties of the lithosphere (the rocky shell that forms Earth's exterior) are affected by the way that mantle & crust respond to these perturbations. Therefore, understanding the dynamics of Isostasy

helps up figure out more complex phenomena such as →

- Mountain Building,
- Sedimentary Basin Formation,
- The Break-up of Continents &
- The formation of New ocean Basin etc

⟹ Concept of the theory of Isostasy

Isostasy is an alternative view of Archimedes principle of Hydrostatic Equilibrium.

Theory of

Isostasy was developed from Gravity Surveys in Himalayas mountains of India in 1850s. The term was first proposed by Clarence Edward Dutton (an American Geologist) in 1889. He said, the "State of Balance (ISOSTASY) which he thought must exist between large upstanding areas of the Earth's surface, Mountain ranges & plateaus & Contiguous lowlands, etc. He proposed his principal of Isostasy in the paper (1892) "on some of the Greater Problems of Physical Geology", in which he states that "Wherever Equillibrium exist in the earth surface, equal mass must underlie equal surface area". In other words, a great Continental Mass must be formed of lighter material than that supposed to Constitute the ocean floor. Thus their exist a Gravitational Balance between crustal segment of different thickness.

But the first idea of Mass balancing of the Earth's upper layer goes back to Leonardo da Vinchi.

(A body at rest in a fluid is acted upon by a force pushing upward called the buoyant force.)

~~On the upward force a fluid exerts on an object~~ Archimedes' Principle is the fact that Buoyant force is equal to the weight of the displaced fluid)

Theory of Isostasy is the Fundamental Concept in Geology, as well as in Geography, is based on the opposing influence of two main forces → ① Gravitational forces & ② Buoyancy forces. It is the state of Gravitational equilibrium between the Earth's crust & Mantle. It is the idea that the lighter crust must be floating on the denser underlying Mantle. The crust floats at an elevation that depends on its Thickness and Density.

⟹ Postulation of Airy's View → Sir George Airy was the professor of Mathematics & Astronomy in Cambridge university ~~postulates explain~~ Proposed the scientific explanation of the Concept of Isostasy.

Theory ① According to him "the crust of relatively lighter materials floating in the substratum of denser materials. In other words SIAL is floating in SIMA". 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. Thus, the Himalayas are floating in denser glassy Magma.

② This view is called ~~the~~ "The Law or Principle of Floatation" in Isostasy, in which, the Himalayas are floating in the denser Magma ~~in the same way that for example~~ with their maximum portion sunk in the Magma in the same way as a boat floats in water with its maximum parts sunk in the water.

Joly 1x? J.A. Steers

eg → Iceberg

1 by 9 parts

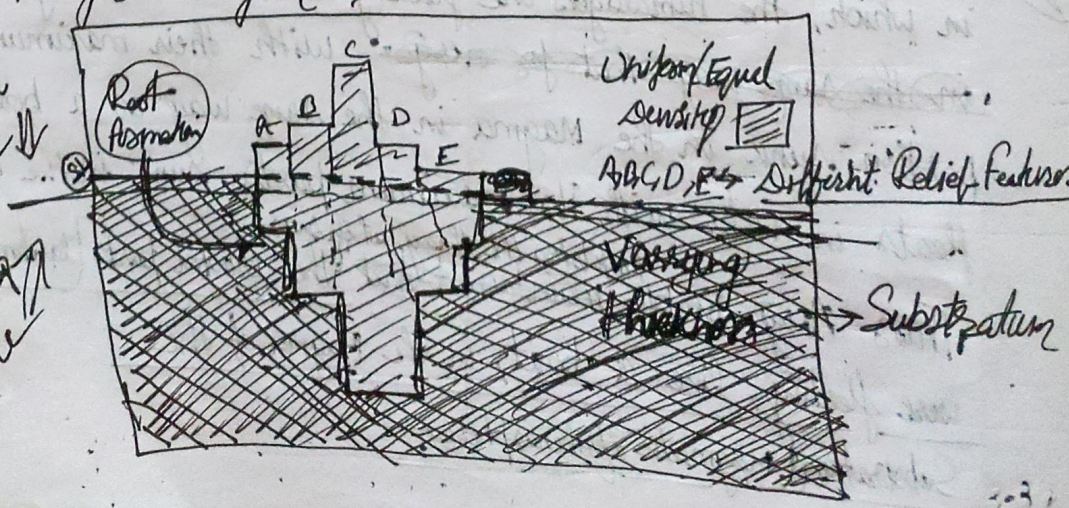
Thus Airy simply ~~maintained that~~ populates the theory, which says - "the crustal parts (landmass) were floating, like a boat, in the Magma of the Substratum (Magmatic Asthenosphere).

But they didn't mention this eg.

If we apply the law of Floatation, as stated above, thus according to Airy the Himalays were exerting their real attractional force because these existed a Long Root of lighter material in the Substratum which compensated the material above. Based on the above observation Airy postulated the "Root Formation hypothesis" which says →

"If the land column above the Substratum is larger, its greater part would be submerged in the substratum & if the Land column is lower, its smaller part would be submerged in the substratum".

This Concept further ~~extended~~ explored through Airy and states that, "the density of different columns of the land (eg → Mountains, plateaus, plains etc) remains the same". This means that the Continents are made of rocks having uniform density but their thickness or length varies from place to place. In other words, Density doesn't change with depth, that is, "Uniform density with varying thickness". The Concept of Airy's law of Isostasy are mention below through the diagram →



It means that crustal layer is uniform in terms of density with varying length of columns. Therefore, these columns are projecting down into the Asthenosphere depending upon the protrusions of the columns. It is due to this reason that the roots has developed @ the Himalaya has been displaced from below.

~~Conclu~~

Conclusion → Though the Concept of Sir George Airy Commands great respect among scientific Community but it also suffers from certain defects & errors through the concept of Root hypothesis in Isostasy, because such a long root (eg. Himalaya) would melt due to very high temperature as increases with increasing depth at the rate of 1°C/32 metre. ~~Also ... the Earth's radius is 6370 Km~~ But quite recently, however the fundamental Concept of Airy "the Continental masses floating as lighter blocks in a heavier substratum," has been rejuvenated because of Plate tectonic Concept.

~~Postulation of Archdeacon Pratt~~

→ To prove this Concept, Airy took an example of Wooden Blocks of various sizes and immersed them into water. All blocks are of same density. They get immersed differently in proportion to their sizes. In the same way higher features with great height seen on the surface of the Earth have deeper roots whereas short in length has shorter roots beneath.

(प्रयोग द्वारा प्रमाणित)

⇒ Postulation of Archdeacon (आर्चडीकन) Pratt →

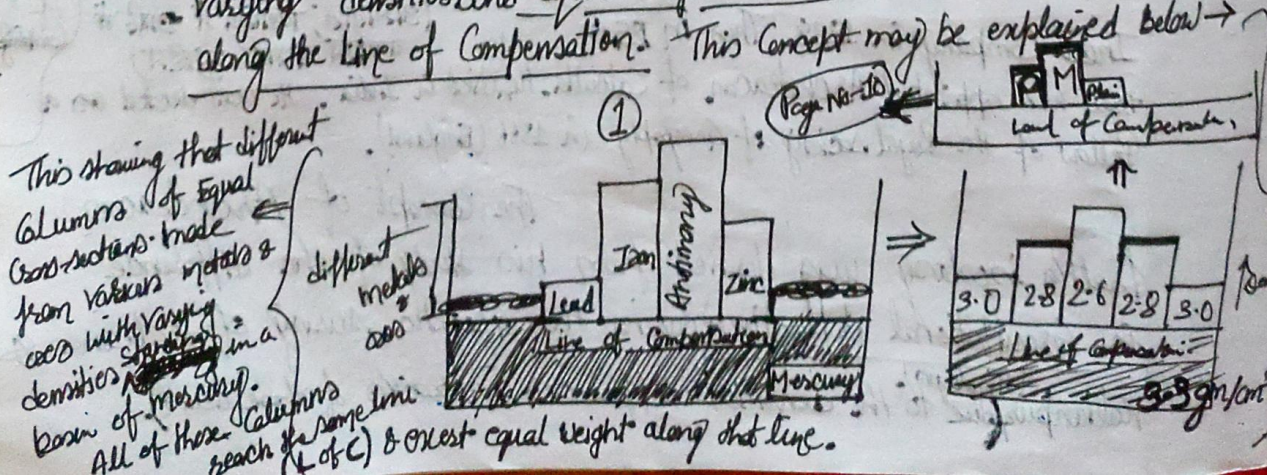
John Henry Pratt was a British Astronomer & Mathematician. He graduated in University of Cambridge.

A John Pratt worked in India as a CHAPLAIN (अस्पताल, विद्यालय में ... में कार्यरत ईसाई पुरोहित) with the East India Company in 1838. Then in 1850 also Pratt was appointed Archdeacon of Calcutta. He died in India. He was elected as a Fellow of the Royal society of Geography in 1866 (England).

The Concept of Archdeacon Pratt's isostasy was derived from his study of the difference in Gravitational deflection during the Geodetic survey of Kaliana & Kalianpur (Himalayas) due to the densities differences in rocks of these areas].

According to him, "There is an Inverse Relationship" between the height and their respective densities". In other words, the density of mountains is less than the density of plateaus, ~~that of~~ plateaus is less than the density of plain & the density of plain is less than the density of oceanic floor & so on. Thus, the Pratt's Concept of inverse relationship between the height of different columns & 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 & not in the Tyrosphere & Barysphere. ~~Thus he~~ He said, that 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 doesn't change within one column but it changes from one column to other columns above the Level of Compensation. Thus, Pratt's ~~Thus~~ Concept of isostasy was related to the "LAW OF COMPENSATION" and not to "the Law of floatation". According to him 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 and equal surface area must underlie equal mass along the line of Compensation. This Concept may be explained below →



While making a comparative analysis of the views of Airy and Pratt on Isostasy Bowie has observed that the fundamental difference between Airy's & Pratt's views is that the former postulated a Uniform density with varying Thickness, and the latter a Uniform depth with varying density →

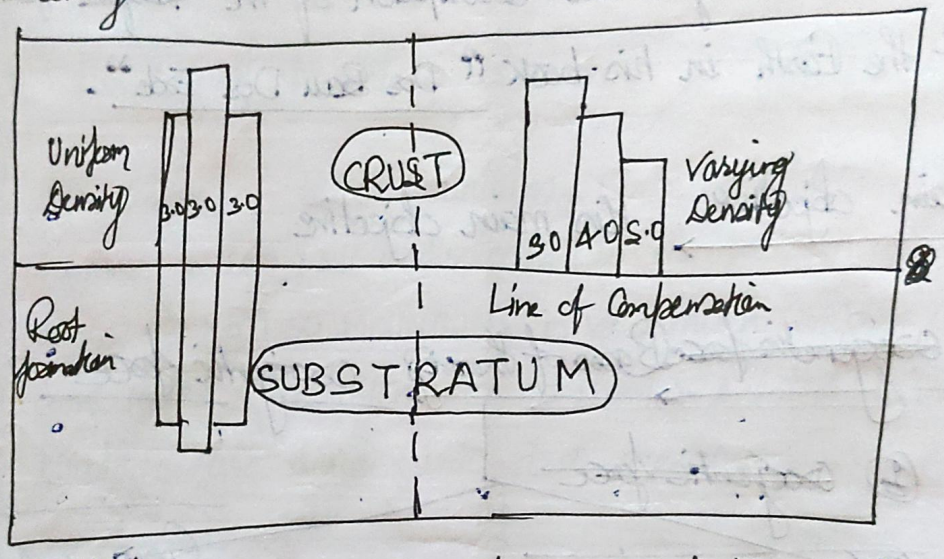


Figure:→ Comparison of the view of Airy & Pratt on Isostasy

Also, Airy model is used for Continental topography especially mountain ridges, but Pratt model is used for Mid Oceanic Ridges.