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Revisiting "Ocean Depth closest to the Center of the Earth"

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Abstract

In a recent study, a method for calculating the distance of a location on the lithosphere from the center of the Earth was presented. This method was applied to show that Molloy Deep in the Arctic Ocean was actually 14.369 km closer to the center of the Earth than Challenger Deep in the Pacific Ocean, the deepest part of the world ocean, even though the latter was 5.534 km deeper than the former as measured from the sea level. Since Molloy Deep is known to be the deepest part of Arctic Ocean, it was concluded that this was also most likely to be the closest point of the solid lithosphere from the center of the Earth. In this paper we re-examine that assertion by calculating the distances from the Earth's center of other ocean deeps in the Arctic and Antarctic waters, which can potentially be even closer to the Earth's center than Molloy Deep and whereby overthrow the latter from its title. It was found that Litke Deep, the previously known deepest point of Arctic Ocean, was actually 0,1793 km closer to the Earth's center than Molloy Deep and therefore displaces the latter from its title. The two were followed by the Arctic Ocean floor at North Pole, Factorian Deep of Southern Ocean, Meteor Deep of South Atlantic Ocean and Denman Glacier valley at the edge of Antarctica, each of which was over 10 km closer to the Earth's center that Challenger Deep.

INTRODUCTION

In a recent study, a method for calculating the distance of a location on the lithosphere from the center of Earth was presented [1]. This method was applied to show that the deepest location of the Arctic Ocean called ***Molloy Deep/Hole*** was actually 14.369 km closer to the center of the Earth than ***Challenger Deep*** of Pacific Ocean, the deepest part of the world ocean, even though the latter was 5.534 km deeper than the

former as measured from the sea level [1]. Since Molloy Deep is known to be the deepest part of Arctic Ocean, it was concluded that this was also most likely the closest point of the solid lithosphere to the center of the Earth. Since then, an unconfirmed report suggests that ***Litke Deep***, the previously known deepest point of Arctic Ocean, may be closest to the center of the Earth [2]. We are thus compelled to re-visit this matter by examining other locations in the Arctic and Antarctic regions, which can potentially be closer to the center of the Earth than Molloy Deep and whereby overthrow the latter from its title. Specifically, we calculate the distances from the center of the Earth of the following in addition to those of Reference [1]: ***Litke Deep***; Depth of ***Arctic Ocean*** at North Pole; ***Factorian Deep***, the deepest part of Sothern Ocean; ***Meteor Deep***, the deepest part of South Atlantic Ocean; and ***Denman Glacier depth***, the deepest part of the Antarctica coast.

METHOD

The method is outlined in Reference [1]. If r is the ***radial distance of the location from the center of the Earth***, d is the ***depth of ocean*** at that location and δ is the ***geoid height*** from the ***reference ellipsoid of the Earth***, then the distance of the ocean depth from the center of the Earth is:

$$D = r + \delta - d \tag{1}$$

Note that r and δ are positive radially upwards, whereas d is reckoned positive downwards. Hence the negative sign of d in Eq. (1).

In a ***geocentric coordinate system*** with a meridional section containing the reference location,

$$r = \sqrt{x^2 + y^2} \tag{2}$$

where x represents the ***abscissa*** in the equatorial plane, and y represents the ***ordinate***.

The ***geocentric latitude*** φ_0 of the reference location is calculated from the ***geographic latitude*** φ by the equation [1]:

$$\varphi_0 = \tan^{-1}\left[\left(1 - e^2\right)\tan\varphi\right] \tag{3}$$

where e = .081819 is the ***eccentricity*** of the reference ellipsoid of the Earth [3]. If a is the ***equatorial radius*** of the Earth (6,378.137 km) and b is the ***polar radius*** (6,356.752 km) [3], then:

$$x = \frac{ab}{\sqrt{b^2 + a^2 \tan^2 \varphi_0}} \tag{4}$$

and

$$y = x \tan \varphi_0 \tag{5}$$

r is calculated from Eqs. (2) – (5); δ can be conveniently determined from ***Online Geoid Calculator using GeoidEval Utility*** [4] by inputting the geographical latitude and longitude of the reference location and d is taken from the latest measurements found in the literature, whence the required distance D is calculated from Eq. (1).

RESULTS

In our previous study [1], the distances of Challenger Deep and Molloy Deep from the center of the Earth were computed and compared. The ***Challenger Deep*** (latitude 11°21′N, longitude 142°12′E), at the end of the crescent-shaped Marianas Trench in the western Pacific Ocean, is the deepest part of the world ocean [5] whereas ***Molloy Deep*** (79°8′12″N, 2°49′E) is the deepest part of the Arctic Ocean [6]. In spite of being only about half as deep as Challenger Deep, Molloy Deep was over 14 km nearer to the center of the Earth than Challenger Deep [1]. In this study, the depths of the two deeps were revised in accordance with the latest measurements by the ***Five Deeps Expeditions*** [7] and entered in Table I.

Table I. Distances of Ocean Deeps from Center of the Earth

Ocean Deep	Latitude ϕ	r, km	d, km	δ, km	D, km
Litke Deep	82°24′13″ N	6,357.1288	5.450	0.0255	6,351.7043
Molloy Deep	79°08′12″ N	6,357.5178	5.669	0.0348	6,351.8836
North Polar Depth	90°00′00″ N	6,356.7520	4.261	0.0149	6,352.5059
Factorian Deep	60°28′28″ S	6,361.9788	7.434	0.0117	6,354.5569
Meteor Deep	55°13′28″ S	6,363.7488	8.266	0.0040	6,355.4863
Denman Glacier	66°45′00″ S	6,360.1080	3.500	– 0.0026	6,356.6054
Challenger Deep	11°21′00″ N	6,377.3154	10.925	0.0407	6,366.4311

We further calculate distances of other ocean depths from the center of the Earth. Since the south polar region is occupied by Antarctica, the potential challenge to Molloy Deep is likely to come from the Arctic Ocean. First and foremost, ***Litke Deep*** (82º24′13″N, 19º31′1″E), previously thought to be the deepest point of Arctic Ocean [8 – 10] at 5.450 km below sea level is 1.219 km shallower than Molloy Deep from the sea level, but is located 3º16′ farther north of the latter. ***Its distance from the center of the Earth just pips that of Molloy Deep by 0.1793 km!*** (Table I). It must be recalled that ocean depth measurements are not as precise as say mountain height measurements, and measurements do vary [7]. However, if we apply the deepest measurement of Molloy Deep (5.770 km) [7], ***Litke Deep still comes out to be 0.1010 km close to the center of the Earth than Molloy Deep***. Unless future measurements indicate otherwise, as of now, ***Litke Deep is the closest place of the Earth's crust from its center***.

Because of the ***latitudinal dependence of geocentric radius*** of the reference ellipsoid of the Earth, we include the Arctic Ocean floor at ***north pole*** (90ºN) in our calculation of the radial distances from the Earth's center. The north pole sits in the middle of ***Fram Basin*** under the Arctic Ocean surrounded by a generally flat terrain [11]. As a result, it is quite likely to be the deepest location in the surrounding area. Here, the radial distance of the reference ellipsoid from the center of the Earth is simply the polar radius of the Earth (6,356.752 km). From the estimated depth of the ocean floor of 4.261 km at north pole [12] and the geoid elevation of 0.0149 km, the required distance calculates out to be 6,352.5059 km (Table I).

We next turn our attention to the southern waters of the world ocean. The South Sandwich Trench, east of the South Sandwich Islands, contains two significant deeps. First, the newly located ***Meteor Deep*** (55º13.47′S, 26º10.23′W) at 8.266 km deep, is the deepest point of South Atlantic Ocean [13]. Second, south of the 60ºS parallel, at (60º28.46′S, 25º32.32′W) is a location proposed to be named "***Factorian Deep***", which at 7.434 km below sea level, is the deepest point of the Southern Ocean [13]. The calculated distances of the two deeps makes the Factorian deep nearly 1 km closer to the center of the Earth than Meteor Deep (Table I).

Finally, there is an interesting case of a depression in the Earth's crust, which perhaps calls for honorable mention. On the eastern edge of the continent of Antarctica is ***Denman Glacier*** whose valley at (66º45′S, 99º30′E) is a deep 3.5 km below the sea level, even if its valley is covered with ice rather than sea water [14]. Its calculated distance D of 6,356.6054 km still places it nearly 10 km closer to the center of the Earth than Challenger Deep which is 10.925 km below the sea level (Table I).

SUMMARY

In general, the geocentric latitude most strongly affects the distance from the Earth's center, followed by the depth from the sea level. Of the seven deep locations on the Earth's crust, the top three closest to the center of the Earth, are found in the Arctic Ocean (Litke Deep, Molloy Deep and North Polar Depth); and the next three are

found in the southern hemisphere around Antarctica (Factorian Deep, Meteor Deep and Denman Glacier valley). Challenger Deep, the deepest point below the sea level is more than 10 km farther away from the Earth's center than any of the above depths (Table I). As it stands now, ***Litke Deep has overthrown Molloy Deep for the title of the nearest point of the Earth's crust to the center of the Earth***.

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