EUROPEAN JOURNAL OF EARTH SCIENCE AND GEOLOGY
ISSN: 2190-0977
Volume 01, Issue 02, September,2019

Ocean level – geomagnetic extremity connection as result of revolution geodynamics.

J. Mugabade[1], G. Nagamube[2]
School for Human Resource and Development, Jomo Kenyatta University of Agriculture and Technology,
P. O. Box 62000- 00200 Nairobi, Kenya[1, 2.]

Abstract— The general inclinations of ocean level and geomagnetic extremity advancement spoken to by their individual polynomial pattern lines are metrically compatible and generally incidental at the principal request and prevailingly at the second request periodicities. Our examination uncovers sequential connection of ocean level highs and lows with the calm and disturbed conditions of geomagnetic field, both causally identified with the thickness subordinate turn compelling of maritime/mainland outside layer and the internal/external center masses individually. Their connection along these lines affirms the job of revolution irritations as a typical pacesetter of the World's surface and inside procedures.

Keywords— Ocean level; Geomagnetic inversions; Turn geodynamics; Geochronology.

1. Introduction

Since the early XIX century to the present day, ocean level change was perceived, in spite of the fact that on various hypothetical premises (diluvialism and fluvialism [1]), as the central point of paleogeography of an unequivocal, or if nothing else huge, sway on organic development. In stratigraphic groupings, ocean level vacillations are spoken to by shifts of marine/non-marine facies comparing to progresses/retreats of shore lines (beach front onlaps). Proof of ocean level change originates from the facies records of profundity changes and the associative disintegration vacillations ashore. Ordered relationship of such nearby records over huge croconic territories shows worldwide scale occasions.

Quantitative appraisals of ocean level changes rely upon what is acknowledged as invalid level, for example the present-day ocean level, mean ocean level or measurable standard for a period interim, the clearly customary assessments. Be that as it may, on the worldwide scale, the present day shore line’s approach the geographical limits of mainland and maritime outside layer thickness spaces, the more slender and denser maritime hull being secured via ocean, the thicker mainland covering being generally uncovered as land or privately immersed. Through topographical history, shore lines had more than once progressed over the present-day land masses a long way past their present degree, while ocean withdraws underneath the present level appear to be uncommon. These and related perceptions make ocean level change analyzable as a hydrosphere impact of differential thickness depended speeding up of maritime and mainland outside layer spaces [2]. In this paper, the pivot ocean level model is additionally expounded by uncovering relationship between ocean level change and geomagnetic inversions, an intelligible revolution marvel.

2. Material and Methods

Late accumulation of ocean level information [3], in view of [4 – 6] are related with the geomagnetic extremity graph by Ogg et al. [7] brought to a similar time scale. Ocean level variances are spoken to as a summed-up ocean level bend with highs and lows in respect to the present-day level. The geomagnetic extremity scale is discretionary separated into the more drawn out than 5 million years (myr) interims (magnetochrons) that are assigned as 'consistent' of either ordinary (N) or turned around (R) extremity, 'semiconstant' of some extremity clearly common (Nr, Rn), and blended (M) of the two polarities similarly spoke to or about so. Relationship of ocean level variances and geomagnetic extremity is induced from the watched sequential correspondence of ocean level highs and lows to the consistent (semiconstant) versus blended extremity magnetochrons (Table 1; Fig. 1)

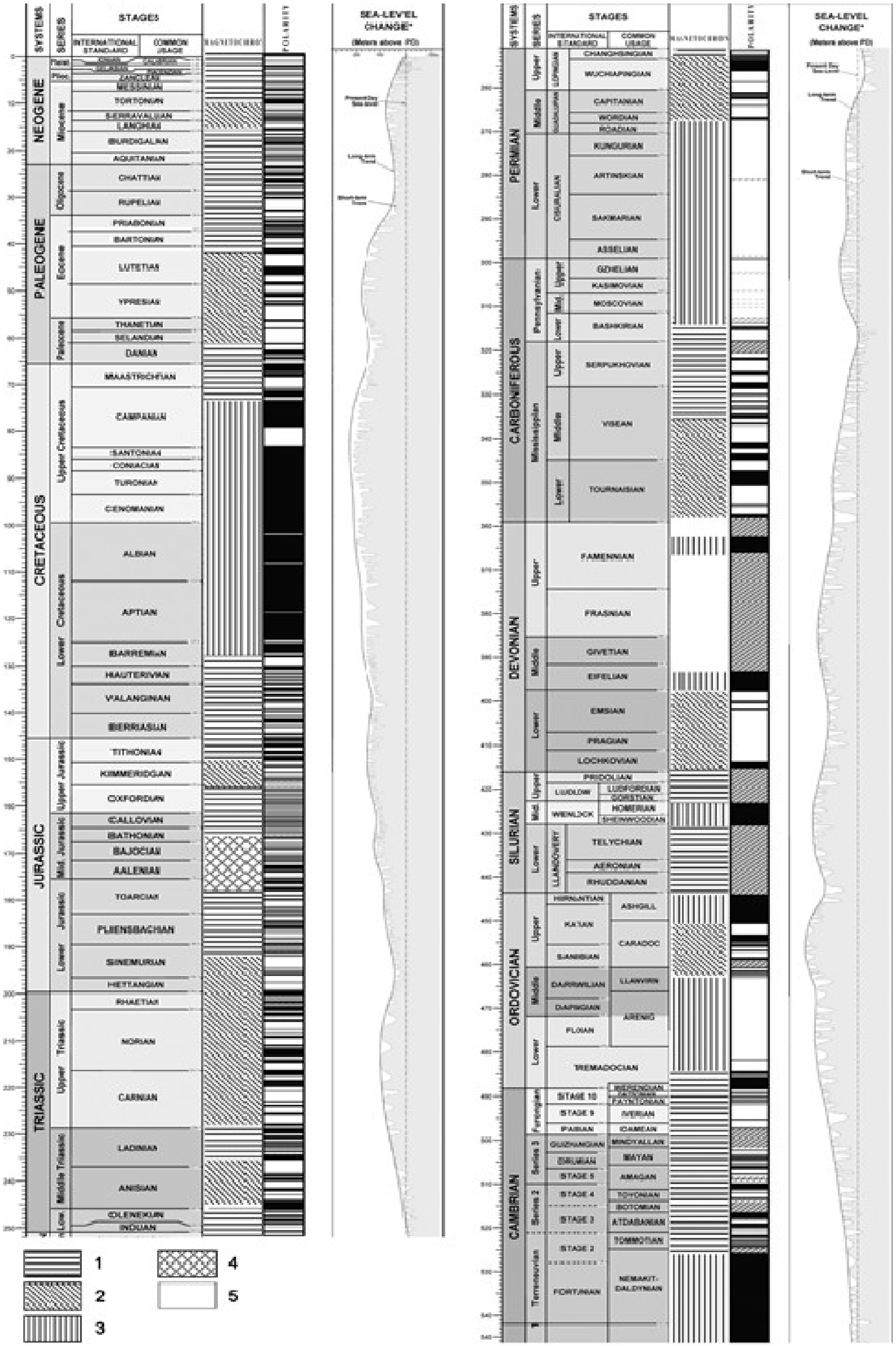

Figure 1. *The arbitrary defined magnetochrons of mixed, M (1), semi-constant reversed/normal, Rn (2), constant, N, R (3), semi-constant normal/reversed, Nr (4), and uncertain polarities (5) inserted against sea level [3] and polarity reversal sequences [7].*

Table 1. *Chronology of sea level cycles and their correlation with geomagnetic polarity scale.*

I order epeirochrons	Stage	Ma	Magnetochron	Polarity	
SLL1	Cambrian geocratic	Tommotian–Tremadocian	550–522	Cambrian mixed	M
SLH1	Mid-Paleozoic talassocratic	Tremadocian–Emsian	522–335	Mayer superchron –	R–M
				Sayan hyperchron	Rn
SLL2	Paleozoic/Mesozoic geocratic	Visean–Ladinian	335–230	Carboniferous mixed series –	M
				E series	Rn
				E series, M series,	Rn
SLH2	Meso-Cenozoic talassocratic	Carnian–Rupelian	230–34	K Nor al–	M
				C13	N
SLL 3	Oligocene – Present geocratic	Rupelian–Present	34–0	C1–C12	M, Rn
Sea level peaks					
		Caradocian	458		Rn
		Llandoverian/Wenlockian	428		M/N
		Givetian/Frasnian^{+}	387	“Poorl known”	T
		Mid-Tournaisian	351	Carbon mixed	Rn
		Gzhelian/Asselian	302	Kiama	R
		Norian	213	E14/E15	Rn
		Bajocian/Bathonian^{+}	168		Rn
		Kimmeridgian/Tithonian	151	M22– 24	Rn
		Santonian/Campanian	84	Cretaceous N/C 33	N/R
		Ypresian	53	C21/C 2	Rn
		Serravallian/Tortonian	12		Rn
	Sea level troughs	Arenigian/Llanvirnian	466		N/M
		Ashgillian/Llandoverian	443		NM
		Pragian/Emsian^{+}	406	“Poorl known”	T
		Famennian/Tournaisian^{-}	357	Carbon mixed	M
		Serpuchovian/Bashkirian	318	Carbon mixed	M
		Changhsingian/Induan	251	Illawara	M
		Hettangian/Sinemurianian	197		Rn
		Berriasian/Valanginian^{-}	138	M15/M16	M
		Danian/Selandian+	63	C26/C/27	Rn
		Rupelian/Chattian	30	C9/C1	M

Symbols $^{+}$ and $^{-}$ signify slightly below or slightly above the conventional stage boundary.

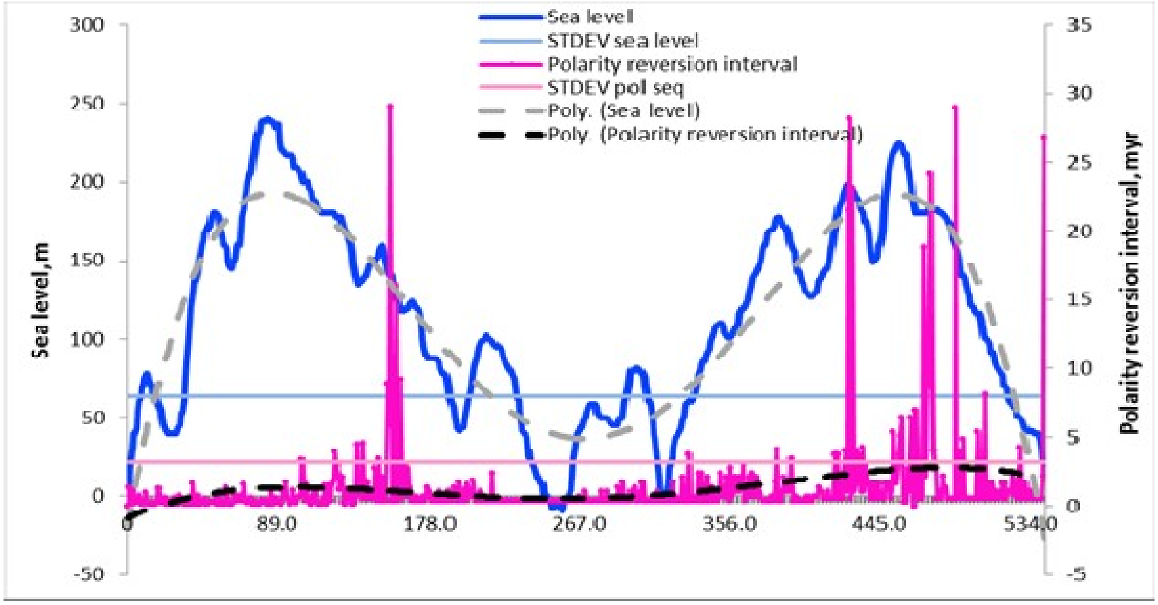

Figure 2. *Curves and polynomial trend lines of sea level (data after [3]) and geomagnetic polarity intervals (data after [7]) over 534 myr. Standard devi- ation lines (STDEV) represent statistically normal sea level and reversal frequency, respectable.*

So as to analyze the Phanerozoic patterns of ocean level and geomagnetic extremity change, the summed-up ocean level bend is reproduced by plotting ocean level with 1 myr interim against terms of extremity inversion interims (Fig. 2). Standard deviation line of the diagram speaks to the measurably ordinary ocean level for 542 myr. The ocean level highs (SLH) and lows (SLL), relating to the thalassocratic and geocratic epeirochrons respectively, can now be assessed against this level. Sequential connection of ocean level and geomagnetic inversions is communicated by the happenstance of pinnacles and troughs of their particular polynomial pattern lines (Fig. 2).

3. Results

3.1 Ocean Level

The summed-up ocean level bend (Fig. 1) is distinct into the principal request highs and lows, containing the subsequent request cycles. It is raised over the present-day level aside from during the end-Permian low that isolates the Paleozoic and Meso-Cenozoic megacycles (Table 1). The Paleozoic cycle begins with an expansive Ediacarian – Cambrian low (SLL1), steadily climbing through the Early – Center Ordovician to the Late Ordovician (Caradocian) crest (SLH1), and stays high until about the Devonian/Carboniferous limit, from where an incredible plunge begins and broadens once again the Mesozoic/Paleozoic change. The auxiliary Paleozoic highs have their defining moments at about the Early/Center Ordovician (mid-Arenigan) , Silurian/Devonian (mid-Wenlockian), and the Center/Late Devonian (Givetian/Frasnian) limits. A low-level beat rise reaches out between the profound lows at the Mississippian/Pennsylvanian limit and at last Permian (Wuchiapingian/Changhsingian)

The Meso-Cenozoic interim between the end-Permian and Pleistocene lows starts with a long drop over a progression of the successively expanding optional crests in the Late Triassic (Norian), mid-Jurassic (Bajocian), Late Jurassic (Kimmeridgian–Tithonian) to the Late Cretaceous (Santonian–Campanian) high, from where a slipping pattern leads through a progression of the consecutively diminishing tops in the Eocene (Ypresian–Lutetian) and Miocene (Serravalian–Tortonian) to the ongoing low.

3.2 The Geomagnetic Extremity Scale

The geomagnetic extremity scale [7] is a grouping of ordinary (N) and turned around (R) interims. "Transitional" interims (T) compare to generally feeble dipole field overwhelmed by numerous parts, likely spoken to by "questionable" interims in the Devonian and somewhere else [8]. The frequencies of N/R rotation (inversion rates) differ over the geomagnetic scale, outwardly separable into the magnetochrons of consistent extremity (N or R), those with some extremity winning (Nr or Rn), and blended (M), with the elective polarities about similarly spoke to. Unmistakable over the geomagnetic successions are the long interims of close steady extremity, customarily perceived as superchrons or hyperchrons with no or a couple of brief time inversions, for example, the Cretaceous Ordinary Superchron (Aptian–Santonian, 84–125 Mama), Carboniferous–Permian Kiaman Turned around Extremity Hyperchron (Bashkirian–Wardian, 265–315 Mama), Devonian Sayan Hyperchron (Lokhkovian–Eifelian, 302–415 Mama), and the Ordovician Mayero Switched Extremity Superchron, (Tremadocian–Arenigian (Dariwillian/Sandbian), 466–484 Mama). They are normal divisions of the geomagnetic extremity scale, albeit to some degree self-assertive characterized, with customary assignments some of the time alluding to the historical backdrop of geomagnetic look into instead of the elements of inversions. The turned around – typical (Rn) arrangements of prevailingly switched extremity, punctuated by the a lot shorter ordinary interims, incorporate the Celasian–Calabrian, mid-Rupelian, Lutetian – mid-Danian (29–64 Mama) of the C-Grouping, the Kimmeridgian – early Tithonian (150–156 Mama) of the M-succession, just as the bigger pieces of the Sinemurian, Norian, Carnian, and Ladinian stages, hindered by the shorter Nr interims at their limits. In the Paleozoic, the undifferentiated from Rn arrangement are recorded in the Visean and Tournaisian stages, yet the more conspicuous in the Center and Late Paleozoic magnetochrons are the Nr arrangement with generally long N interims, as over the Chaghsingian/Wuchiapingian progress, in the upper Tournaisian, upper Famenian, Eifelian, Wenlockian and lower Tremadocian. Since turned around state is measurably more ordinary than the "typical" (present day) state, Rn interims pass on relative geomagnetic soundness. The blended magnetochrons (M) of incessant (about 2.5 myr or less) inversions, with almost equivalent span of ordinary and turned around segments, stretch out over the long stratigraphic interims in the M-Arrangement and the Carboniferous blended magnetochron, including the upper Visean, Pridolian–Ludlowian, Llandoverian, Caradocian (Sandbian–Early Katian), and the Early–mid-Cambrian arrangement Blended interims are likewise recognizable in the Pliensbachian–Aalenian, 190–175 Mama, Berriasian – Hauterivian, 136–146 Mama, and Ruppelian – Aquitanian, 33–21 Mama. Generally short (under 5 myr) blended interims happen at the Late Changsingian part of the Late Permian Illavara Arrangement, 251–264 Mama, just as over the Maastrichtian/Danian, Ruppelian/Chattian, Tortonian/Early Messinian, and Zanclean/Placenzian transboundary interims. The Marine Attractive Irregularity arrangement, Late Bathonian–Kimmeridgian, is appointed a blended interim of amazingly visit inversions [7], however can likewise be deciphered as a calm interim. In regard to the measurements of inversions, the geomagnetic scale is intermittent, with the consistent (semiconstant) and blended interims passing on occasional variation of generally calm (Q) and disturbed (A) geomagnetic field. The main request Q/A cycle sequence is spoken to in Table 2.

Table 2. *Geomagnetic cycles of constant (semiconstant) – mixed polarity magnetochrons (quiet/agitated dipole field states, Q/A) compared to the first order sea level cycles (Table 1).*

I order magnetochrons	Traditional name	Stage	Ma	Epeirochron
AI 530 – 484	Early – mid-Cambrian (M) Series	Tommotian –Tremadocian	530 – 484	SLL1, 550 – 522
Q1 484 – 395	Mayero (R) superchron – Sayan (Rn) hyperchron and intervening N/M series	Tremadocian– Arenigian	484 – 475	SLH1-1, 522 – 428
		Caradockian	491 – 450	
		(Rn)	450 – 443	
		Ashgillian	428 – 423	
		(N),	443 – 428	
		Wenlockian (N), Silurian	425 – 416	
		“mixed polarity		
		intervals”	416 – 395	
		Lokhovian– Eifelian (Rn)		
AII 395 – 265	Late Devonian (N/T) – Carboniferous (M) series	Eifelian – Famennian	395 – 365	SLL2-1, 428 – 335
		Famennian – Bashkirian	365 – 265	
QII	Kiaman (R) Hyperperchron	Bashkirian – Wardian	325 – 267	SLL2-2, 335 – 230
AIII 172 – 315	Illawara series (Rn/M) – Sn1 –E series (Rn),	Capitanian –Changsingian	325 – 267	
		Induan – Anisian	251 – 243	
		Ladinian – Rhaetian	237 – 202	SLH2, 230 – 34
	M series (M/Rn)	Bajocian – Barremian	172 – 125	
QIII 125 – 30	Cretaceous (N) superchron – C33 (N)	Aptian – Campanian	125 – 84 84 – 71	
	C 32 – C12 (Rn)	Maastrichtian – Rupelian	71 – 30	
AIV 30 – 0	C11 – C1 (M/Rn)	Rupelian – Present	30 – 0	SLL3, 0 – 34

3.3 Relationship

Comparing the arrangements of ocean level change and geomagnetic inversions (Tables 1, 2) we locate that long interims of consistent extremity assigned as hyperchrons or superchrons relate to the high or typical (close to the measurement standard in Fig. 1) ocean level stands. The significant ocean level lows separating the primary request epeirochrons happen during the typical to blended Early Cambrian arrangement, the (Visean) Serpuchovian–Bashkirian blended interim, the Late Changhsingian blended interim of the Illavara Arrangement, and the overwhelmingly blended Zanclean – present day interim. Of the Paleozoic auxiliary pinnacles, the Early Ordovician at about the Tremadocian/Arenigian limit, 478 Mama falls in the Mayero Superchron. The most astounding Late Ordovican crest, 458 Mama, happens in the moderately long Caradocian turned around interim of a blended arrangement. The Silurian crest, 428 Mama compares to the Wenlockian (Homerian) long ordinary interim. The Devonian high, 387 Mama, has a place with the "ineffectively examined" transitional interim. The Paleozoic second request ocean level lows at or close to the Ordovician/Silurian, 443 Mama, Silurian/Devonian, 400 Mama, and Devonian/Carboniferous, 357 Mama, limits all relate to the blended extremity interims. In the Meso-Cenozoic megacycle, the Carnian/Norian high, 213 Mama happens in the long Rn succession. The Jurassic highs compare to the Peaceful zone. The pinnacle of the wide Cretaceous high relates as far as possible of the Cretaceous Typical Superchron. The Paleogene crest to some degree beneath the Ipresian/Lutetian limit, 53 Mama, happens in Rn interim. The Miocene high, 12 Mama falls in the blended Serravalian/Tortonian interim, yet with obviously more extensive inversion interims than on its flanks. The Meso-Cenozoic lows at the Hettangian/ Sinemurian, 197 Mama, early Valanginian, 138 Mama, and Rupelian/Chattian, 28 Mama all relate to the blended extremity interims. Along these lines, relationship of geomagnetic inversion frequencies with ocean variance dependent on self-assertive division of the geomagnetic extremity scale into consistent (N, R), semiconstant (Rn) and blended (NR) interims uncovers that ocean level pinnacles will in general agree with steady and semiconstant magnetochrons, while ocean level troughs are all the more regularly restricted to blended extremity magnetochrons. The insights of basic geomagnetic occasions (singular groups of the geomagnetic extremity scale) affirm that long span occasions bunch at or close to the ocean level pinnacles, though brief length occasions reliably beat miseries of ocean level bend (Fig. 2).

Both ocean level changes and the rates of geomagnetic inversion are cyclic; their Paleozoic and Meso-Cenozoic first request cycles agree or extensively cover. The limits of he mid-Paleozoic Q1 geomagnetic extremity cycle characterized by hyperchrons (superchrons), their most unmistakable metric parts, are extensively uprooted against the individual ocean level cycle SLL1, with the most evident disparities in the region of the Sayan hyperchron, the measurements of which is deficiently contemplated, and the uncertain Devonian interims.

Be that as it may, when the geomagnetic extremity scale is plotted as a grouping of individual inversion interims regardless of their visual bunching (Fig. 1), the polynomial pattern lines for seal level and extremity inversion diagrams are comparable (Fig. 1), with the pinnacles and troughs of the main request cycles almost corresponding.

4. Discourse

The connection of ocean level and geomagnetic inversion rate bears on the by and by disputable causal translations of ocean level change, for which the glacioeustasy, hydrospheric geoid impacts, and structurally determined epeirogeny are the fundamental choices. Nearby ocean level variances may result from an aggregate or even synergistic impacts of different variables, however worldwide changes require a satisfactory causation.

4.1 Discourse

Eustasy legitimately relates worldwide ocean levels to ocean water volume variances in regard to the water contributions from softening ice and different sources, just as by warm extension. Initially connected to the Pleistocene ocean level changes, the instrument of glacioeustatic vacillations has been extrapolated over the topographical history, including the non-cold periods. A relationship of ocean level highs with non-icy atmosphere holds for the Late Cretaceous, yet does not hold for the profound and wide low over the Permian–Triassic change that incorporates the Late Permian deglaciation, just as the Early Triassic atmosphere warming.

Then again, the broad Hirnantian glaciation [9,10] is related with the moderately unobtrusive ocean level low over the Ordovician/Silurian limit. Besides, measurements of the second request ocean level cycles is much the equivalent for the chilly and non-frosty periods. The impact of water volume on ocean level isn't immediate, however interceded by isostasy (gravitational equilibration of surface burdens relying upon their thickness) and is accordingly connected with the all-out region and dispersal of the ice (water) secured land masses. This issue is still deficiently comprehended. in any case, in perspective on its generally factor commitment, glacioeustasy is hardly a widespread factor of worldwide ocean level change. Isostasy is usually engaged with geodynamic evaluations of ice burden and post-icy bounce back, yet is really an increasingly broad marvel appropriate to both hydrosphere and lithosphere and including eustasy as an extra wellspring of hydrospheric load. Isostasy hence relates ocean level to the thickness heterogeneity of maritime and mainland outside, clarifying in the broadest terms why these covering d mains are equilibrated at various hypsometric levels, r gulating the dissemination of ocean water over the World's (Fig. 3). The isostatic model along these lines infers that ocean level changes are (not just) a hydrospheric, premier the geodynamic wonder. The epeirogenic ocean level changes are as of now r lated to the World's mantle convection with both nearby and worldwide structural impacts, for example, development of maritime edges, diminished limit of maritime sorrows, just as warm subsidence of maritime lithosphere with the contrary impact. Direct relationship between's ocean level and ocean bottom spreading rates [11] is impossible by virtue of the went with magmatic and transformative procedures dispensing thickness changes, for example, impregnation of lithosphere with mantle tufts [12] and changeable stage advances [13], in this manner definitely including isostatic driving. The alleged impacts of extraterrestrial effects have been associated with clarification of the Devonian ocean level changes [14], albeit no convincing proof was displayed. Regardless, the impact of a goliath sway in any case. Revolution ocean level driving was progressed as a heuristic way to deal with the issue of Pleistocene eustatic cycles [15–20] created in regard to the thickness depended quickening of maritime and mainland covering [2, 21-24]. The real reason of turn geodynamics is that differential speeding up of thickness heterogeneous masses creates both hydrostatic and divaricate stresses, causing removal and redistribution of masses on the Earth' surface and in the inside. The maritime and mainland outside areas are isostatically equilibrated at various hypsometric levels that separate under increasing speed and unite under deceleration of the World's revolution rates, coming about in the, individually, more extreme or gentler incline of the geoid hypsometric bend and retreat (relapse) or advance (transgression) of shore lines (Fig. 3). It is indicated [23, 24] that the geoid hypsometric bend had an apparently gentler incline and was progressively similar to that of the Moon when around 60 % of the present-day land masses have been secured with epicontinental oceans at the pinnacle Generally Cretaceous transgressions. The job of turn compelling can be evaluated by connection of worldwide ocean level change with the other geodynamic procedures driven by Earth's pivot, yet of no immediate impact on ocean level. To the extent that geomagnetic inversions have no considerable impact on ocean level and the other way around, their connection is intervened through pivot constraining.

4.2 Geomagnetic Inversion – Ocean Level Connection

The source of geomagnetic field is presently identified with differential turn of the strong inward center and the liquid external center, going about as stator and rotor of a synchronous electric engine, the liquid center streaming eastbound over the strong internal center [25–27]. Inversions of dipole geomagnetic field emerge in this model under the consolidated activity of outward and Carioles compelling, delivering the helical convection stream. A forecast of the pivot ocean level model is that periodicity of ocean level change and geomagnetic inversions are sequentially related in regard to the elective speeding up/impediment patterns of the World's revolution rates, the ocean level highs and lows generally comparing to the calm and unsettled conditions of geomagnetic field recorded as shift of consistent and blended magnetochrons of the geomagnetic scale. Our outcomes affirm sequential connection between's ocean level and geomagnetic occasions: the dipole geomagnetic field will in general be increasingly steady ("calm") as far as inversion frequencies during thalassocratic times of high ocean level, while it is moderately precarious ("disturbed") during geocratic times of low ocean level. Since ocean level change and geomagnetic occasions are produced at various profundities and include various components (for example isostasy of heterogeneous covering areas and decoupling of the strong/liquid center layers, separately), their ordered connection is just important in regard to differential pivot constraining of both exospheric and endospheric masses. Taking into account that geochronological dating of the worldwide ocean level and geomagnetic inversions are extrapolations of local age assignments, and taking into consideration a period slack between the perceivable ocean level and geomagnetic impacts of a revolution driving, their more exact relationship than in Fig. 2 does not appear to be reasonable. Simultaneously, the pattern lines of the ocean level and geomagnetic inversion bends pass on the similar periodicities of the two procedures. Their first request cycles generally relate to the higher position divisions of geochronological scale, and the limits of the lower request epeiro-and magnetochrons as a rule harmonize with the geochronological age/arrange limits. The variation of ocean level highs and lows seems increasingly ordinary in regard to the factually typical ocean level spoke to as the standard deviation in Fig. 2. The mid-Paleozoic and Meso-Cenozoic ocean level ascents are about symmetrical, 187 myr and 196 myr, individually, while the principal request late Paleozoic – Early Mesozoic low between them is of a practically identical span (144 myr), consequently uncovering the measurements of the main request ocean level cycles. The length of the past geocratic period recommends that the late Cenozoic (Oligocene – Present) ocean level low adds up to about a quarter (34 myr) of the normal first request epeirochron span and will keep going for around 100 myr more

5. Conclusion

The summed-up ocean level and geomagnetic extremity bends are compared to uncover their ordered relationship unsurprising based on the turn geodynamic model, in which the thickness subordinate quickening is a typical pacesetter of both epeiric and geomagnetic occasions. Worldwide ocean level changes are identified with the thickness subordinate radial speeding up of maritime and mainland outside isostatically equilibrated at various hypsometric levels [2]. Geomagnetic inversions are created by the thickness subordinate Carioles compelling over the strong inward center/liquid external center limit [25–27]. The worldwide ocean level bend uncovers intermittent rotation of highs and lows speaking to the first and second request transgression – relapse cycles. The geomagnetic extremity scale is in like manner occasional and distinguishable into steady (semiconstant) and blended extremity magnetochrons, speaking to the generally peaceful and upset conditions of geomagnetic field. The worldwide ocean level highs and lows generally compare to the calm and unsettled conditions of geomagnetic field (steady and blended interims of geomagnetic extremity scale) individually. The ordered relationship of epeirogeny and geomagnetic field development is uncovered by the similarity of the worldwide ocean level and geomagnetic extremity polynomial pattern lines (Fig. 2) and the metric consistency of the first and second request cycles. The primary request epeirochrons and magnetochrons relate to the higher position geochronological divisions (erathems, frameworks), while the defining moments of ocean level and geomagnetic extremity patterns match with stage limits in this way selling out common periodicity at the underlying foundations of geochronological scale. The measurements of epeiric/geomagnetic cycles give a few reasons for foreseeing span of the present geocratic age.

6. References

[1] R.J. Huggett, “Fluvialism or diluvialism? Changing views on superfloods and landscape change”. Progr. Phys. Geogr., vol. 18, pp. 335–342. September 1994.

[2] V.A. Krassilov, Terrestrial Palaeoecology and Global Change. Sophia: Pensoft, 2003.

[3] J.W. Snedden, C.A. Liu,” A compilation of Phanerozoic sea-level change, coastal onlaps and recommended sequence designations”. Search and Discovery Article 40594. Ex- xonMobil Production Deutschland GmbH, 2010, www.searchanddiscovery.org.

[4] J. Hardenbol, J. Thierry, M.B. Farley, T. Jacquin, P.C. Gra- ciansky, and P. Vail, “Mesozoic and Cenozoic sequence chronostratigraphic framework of European basins”, In Mesozoic and Cenozoic Sequence Stratigraphy of European Basins, P.C. Graciansky et al. Eds. SEPM Special Pub. no. 60, 1998, pp. 3–13.

[5] B.U. Haq and Al-Qahtani, “Phanerozoic cycles of sea-level change on the Arabian Platform”. GeoArabia, vol. 10, no. 2, pp.127–160, 2005.

[6] B.U. Haq and S.R. Shutter,” A chronology of Paleozoic sea-level changes”. Science, vol. 322, pp. 64–68, October 2008.

[7] J.G. Ogg, G. Ogg, and F.M. Gradstein, Concise Geologic Time Scale. Cambridge: University Press, 2008.

[8] M. Kono, “Palaeomagnetism and palaeointensity studies of Scottish Devonian volcanic rocks”. Geophys J. Intern., vol. 56, no. 2, pp. 385–396, February 1979.

[9] A. Delabroye, and M. Vecoli, “The end-Ordovician glacia- tion and the Hirnantian Stage: A global review and questions about Late Ordovician event stratigraphy”. Earth-Sci. Rev., vol. 98, no. 3, pp. 269–282, 2010.

[10] S. Finnegan, K. Bergmann, J.M. Eiler, D.S. Jones, D.A. Fike,
I. Eisenman et al. “The magnitude and duration of Late Or- dovician–Early Silurian glaciation”. Science, vol. 331, no. 6019, pp.903–906, February 2011.

[11] C.G.A. Harrison, “Long term eustasy and epeirogeny in continents.” In Sea-level Change, Geophysics Study Com- mittee, National Research Council, Ed. Washington D.C.: Academic Press, 1990, pp. 141–158.

[12] D.M. Pechersky, “The geomagnetic field at the Paleo- zoic/Mesozoic and Mesozoic/Cenozoic boundaries and lower mantle plumes”. Izvestiya, Phys. Solid Earth, vol. 43, no. 10, pp. 844–854, 2007.

[13] E.V. Artyushkov and P.A. Chekhovich, “Mechanisms of sea-depth changes in Silurian epeiric basins of east Siberia”. Russian Geol. Geophys., vol. 45, no 11, 1219–1236, 2004.

[14] C.A. Sandberg, J.R. Morrow, and W. Ziegler, “Late Devonian sea-level changes, catastrophic events, and mass extinctions”.

[15] Geol. Soc. Amer. Spec. Paper, 356, pp. 356-473, 2002.

[16] N.-A. Mörner, “Eustatic changes during the last 300 years. Palaeogeogr. Palaeoclim. Palaeoecol., vol. 13, no. 1, pp. 1–14, March 1973.

[17] N.-A. Mörner, “Eustasy and geoid changes as a function of core/mantle changes”. In Earth Rheology, Isostasy and Eus- tasy, N.-A. Mörner, Ed. N. Y.: Wiley, 1980, pp.535–553.

[18] N.-A. Mörner, “The concept of eustasy: a redefinition”. J. Coastal Res. Special issues 1, pp. 49–51, 1986.

[19] N.-A. Mörner, “Models of global sea level changes”. In Sea level Changes, M.J. Tooley and I. Shennan, Eds. Oxford: Blackwell, 1987a, pp. 333–355.

[20] N.-A. Mörner, “Eustasy, geoid changes and dynamic sea surface changes due to the interchange of momentum”. In Late Quaternary Sea-Level Changes, Y. Quin and S. Zhao, Eds. Beijing: China Ocean Press, 1987b, pp. 26–39.

[21] N.-A. Mörner, “Sea-level changes and Earth's rate of rota- tion”. J. Coastal Res., vol. 8, no. 4, pp. 966–971, Autumn, 1992.

[22] V.A. Krassilov, Plate tectonics and rotational dynamics of the planet. Izvestia Acad. Sci. U.S.S.R, Geol., no. 1, pp. 74–82, 1976. (В.А. Красилов, “Тектоника плит и ротационный режим планеты”, Известия Акад. Наук СССР, сер. Геол.№ 1, С. 74-82, 1976).

[23] V.A. Krassilov, “Organic evolution and natural stratigraphi- cal classification”. Lethaia , vol. 11, no. 2, pp. 93–104, April 1978.

[24] V.A. Krassilov, Cretaceous Period. Evolution of Earth Crust and Biosphere. Moscow; Nauka, 1985. (В.А. Красилов, Меловой период. Эволюция земной коры и биосферы. Москва: Наука, 1985).

[25] V.A. Krassilov, “Overview of rotational geodynamics”, Pacific Geology, no. 1. pp. 89–95, April 1991. (В.А. Красилов, “Обзор ротационной геодинамики” Тихоок. Геол., № 1, С. 89–95, 1991).

[26] G.A. Glatzmaier and P.H. Roberts, “A three-dimensional self-consistent computer simulation of a geomagnetic field reversal”, Nature, vol. 377, pp. 203–209, 21 September 1995.

[27] G.A. Glatzmaier and P.H. Roberts, “Rotation and magnetism of Earth's inner core’, Science, vol. 274, no. 5294, pp. 1887–1891, December 1996.