

(editor's note: This paper was transcribed from a handwritten cursive copy with various difficulties. For a perfect rendition, the reader might wish to consult the original, itself a copy, in the volume entitled *Literary Club Papers*, Dec 20, 1890 to May 30, 1891)

Secular Oscillation In the Earth's Crust

From the earliest ages man has held an abiding faith in the solid earth. In contrary fashion he has associated the idea of change with the Sea when any alteration between the level of land and sea was found to be taking place the cry arose that the sea was advancing upon the land, or in the reverse case, that it was diminishing in a way that would, in the end, leave man stranded upon a waterless planet. A course of long and patient observation has however revealed the existence of a never ceasing movement in the curvature of the Earth's crust in which its surface in certain portions of the world is constantly rising or falling.

The opinion that the water which rests upon it, exists from age to age in an unchanging quantity, has furthermore in the process of time, become an established canon of scientific belief. This never ending change of level, the supposed thinness of its crust, which follows as a necessary deduction and the disturbing hypotheses that its interior, beneath this thin crust, is a mass of molten matter constitute a cycle of ideas well calculated to create in the mind the sense of measureless unrest that is inevitably connected with so insecure condition of things. The feeling is however removed in a certain degree by the suggestion that this enormous pressure must, at a comparatively slight depth, bring about a density incompatible with fluidity, or motion as we understand it. This theory has been worked out mathematically and the conclusion arrived at that the matter at the center of the earth must have a density equal to silver.

The oscillations in the Earth's crust are so gradual the passing away of generations of men is required to note the changes that take place. Its slow movement – its arc as of subsidence, well-balanced by upheavals are facts that indicate a condensation still going on. In such a process it follows that the heavier forms of matter will fall to the bottom. The highest mountains are supposed to be of relatively lighter material, and one also believes to be the more recent upheavals. There are evidences of a breaking due to resistance of strata to contraction, a wave of alternate elevation and depression in which the forces of upheaval are counterbalanced by the weight of the rising mass.

The sequence of these changes is not always confined to the immediate physical or climative effects. The rise or fall of a certain region may otherwise affect the fate of the native that inhabits it. England's maritime supremacy has been aided by the constant deepening of its harbors on the southern coasts, by the continuance of the movement which originally separated the island from the continent. In the beginning of the present century the gradual upheaval of North Africa and the consequently increasing shallowness of the ports of Tunis, Algiers and Morocco had already forced the Barbary Corsairs to reduce the size of their vessels. Their capacity for mischief had by reason of this fact, suffered a serious decline before the formation of the league among Christian nations for the suppression of their piratical inroads in the commerce of the world.

The existence of displacements in the Earth's crust, extending from age to age, was not suspected until the early part of the last century. Antonio Lazzaro Moro an Italian, was the first man of science to formulate a theory of slow oscillations continually raising or depressing portions of its surface. His idea failed to have any effect in changing the popular or the scientific belief. The question received adequate consideration for the first time in Scandinavia, a fact due however largely to Occidental causes. Celsius, the astronomer, with the cooperation of Linnaeus, the celebrated naturalist, made numerous observations in regard to the changes occurring in that part of the world. In 1730 he wrote a paper setting forth facts, that as he supposed, indicated a gradual decrease in the volume of the ocean. He was at once denounced by the clergy and charged with impiety and the Swedish Diet, under the active suggestion of the ecclesiastical Power, passed a formal vote of censure upon him. Celsius lived at Uppsala, in a region in which a maximum of change has been going on for centuries. In 1731 in company with Linnaeus, he cut a mark on the rocks on the island of Laeffzrund, and in 1743, was able to register a difference of level in which the sea and land had separated a distance of seven inches, during the interval.

He assumed the discovery of a subsidence of the waters of the ocean at rate of over four feet in a century. He died in the following year at the early age of forty three. The notoriety of these events called the attention of men of science in all parts of the world to this particular matter of investigation. It was observations made on the Baltic however that ultimately led to the reversal of the hypothesis held by Celsius and Linnaeus, and established the soundness of the theory of Antonio Lazzaro Moro, universally held since that time. It was found that the annual rate of change between land and sea on the Scandinavian Peninsula varied at different places on the Baltic. The conclusion inevitably follows that the water in the ocean could not really be diminishing, or otherwise the annual subsidence would be the same at all points on the shore. When it was furthermore established that on the southern shore of the Baltic, the sea was encroaching yearly upon the land. The demonstration was complete.

It is a subject beset with grave difficulties which interfere with the accuracy of conclusions. The lapse of time required to note changes of level, has not been the only hindrance encountered by the observers who gathered the data, upon which this branch of science is founded. The thoughtful investigators are easily led to form erroneous opinions from their opinions. Conflicting evidence has frequently met with upon a coast line, toward which attention is directed. Upheaval may be more than counterbalanced by erosion, so that the opposite condition of depression may be believed to exist. It is also possible as in the case of the Po, that a coastline near a great river may be sinking, yet a continuous extension of the land into the sea due to alluvial deposit, may give the impression that the shore is rising. Sand washed up by the sea must be clearly distinguished from an upheaval. A gain of this kind sometimes proceeds with incredible rapidity and necessarily obliterates all other evidence of change. Between 1768 and 1826, a period of fifty eight years, the point of Cape Ferrel on the French coast in the department of the Gironde, without receiving any material supply of alluvial deposit, moved southward from its previous position, at a rate of projection amounting to two

hundred and seventy five feet per annum, or nearly ten inches for every day during the time. At the mouth of the Girande the sandbank encroaches on the sea at the rate of 190 feet yearly. That part of the coast is believed to be rising, but it is clear that with such an accretion it would be impossible to obtain any accurate observations in regard to the upheaval.

The coast of France on the Mediterranean affords an example of a supposed upheaval where none has really taken place. The town of Aigues Monte is often cited as an instance on which the rising of a coast has carried inland, a port originally on the gulf of Lyons, from which Francis the First is known to have sailed when he went on his expedition to [Tunis]. There has however been no change of level on the shore of the Gulf within historic times. The land formed in front of Aigues Monte is simply an immense deposit of alluvia brought down by the Rhône. It is even possible for shore accretions of recently formed strata to give the false impression that a coast is rising. In tropical countries, under the stimulating influence of intense heat, layer after layer of stone may be built up under an arm of the sea with surprising celerity of growth. This phenomenon may under exceptional conditions occur even in temperate regions. The Museum of Montpellier in France possesses a cannon embedded in calcereous deposit from a few years ago in the gulf of Lyons, at the mouth of the Rhône.

Mistaken influences have sometimes been drawn from glacier marks found on rocks beneath the sea. These indications have been received as proof that the adjacent coast has sunk from a former elevation above the existing sea level, maintained by it at the time it was subjected to the action of ice during the glacier epoch. The conclusion is inconsequent, as may be seen in existing coast line glaciers. The mass of ice and snow may as it passes into the ocean act upon land surfaces both above and below the sea level. Ice has no tendency to float until more than 9/10 of its bulk is submerged. A glacier of immense thickness of the accumulations upon the shores of Alaska and Greenland must, in descending into the sea over a long rocky incline necessarily leave marks of its passage on the rocks at a great depth below the surface. At the mouths of the Amazon there is no extension of the land into the sea. Notwithstanding the enormous alluvial deposit brought down by its waters. The entire north eastern coast of Brazil is gradually subsiding beneath the Atlantic, since the original formation of the continent the ocean has encroached upon the land a distance of 300 miles. The Ikapicuna and the Paranabyba, two important rivers which formerly fell into the Amazon now pass directly into the sea.

One of these rivers the Paranabyba empties into the Atlantic at a distance of more than five hundred miles to the south eastward of the mouth of the Amazon. Another large tributary the Tocantius is now only indirectly connected with the Amazon by a lagoon extending around the island of Marajo that lies between the mouth of the river Para and the main stream. On the western coasts of South America the range of the Andes is rising. In certain parts owing probably to condensation of materials of which these mountains are composed, the reverse condition exists. In 1745 the city of Quito in Ecuador was 9596 feet above the sea, and in 1867, 9520 feet, a subsidence of 76 feet in 122 years. The peak of Prichincha sank 218 feet during the same period of time. At one point, the [farm] of Antisana 4000 feet higher than Quito, the rate of depression exceeds thirty inches a

year, a rate which has been maintained for sixty four years. An upward movement of the Earth's crust extends from the northern coast of South America through Trinidad, the Windward and Leeward Islands, the Greater Antilles and the Bahamas, to the Peninsula of Florida, which is also rising from the ocean. Prof. [Heil-----] has recently verified the conclusions of previous observers, and has especially noted unmistakable marks of rapid upheaval in the island, New Providence in the Bahamas. In the course of centuries, a continuance of this upheaval would turn the Caribbean Sea and the Gulf of Mexico into inland seas.

On the coast of Louisiana and Capes the land is rising. The upheaval tends to disturb the outflow of the Mississippi River. In Georgia a reverse action begins. Almost the entire shore line of the United States from Savanna northward to Point Judith is affected by a slow downward movement in which the land is subsiding into the sea, at the rate of twelve inches in half a century. Where modifying circumstances do not exist, the change results in a gradual deepening of the harbors. On the New Jersey and Delaware coasts the farmers lose every twenty five years, one acre of ground for each square acre fronting on the ocean. It is a phenomenon that has been going on for centuries. It is said that the early settlers on Manhattan Island were told by the Indians, that they had learned by tradition from their fathers, that at a time far back in the past, they were able to pass by dry land from what is now Long Island to a point on the northern shore of the Sound not far distance from the mouth of the Harlem River.

Salvador and New Foundland are in the course of the usual reactionary impulse given to the Earth's crust now arising out of the sea. Still farther north, another reversal of conditions is found. The southern portion of the Peninsula of Greenland is gradually being depressed, while the upper part as far as it can be explored toward the North Pole, is undergoing an upheaval, which is known to extend to the seventy fifth degree of latitude. The remarkable upheaval going on in Sweden has been referred to. Collateral proof of the recent elevation of the land appears in the extraordinary numbers of lakes in that country variously estimated to cover from one twelfth to one eighth part of its surface. An upward motion is supposed to extend over the entire peninsula. In northern Norway it is believed to be a greater rate of upheaval than is found in any other part of the globe. Although it has been recently asserted that the existence of any movement of that kind is at the present time, extremely questionable. The upward motion extends southward in Sweden beyond the Trolhatten Canal. An excavation made through a region interspersed with lakes, which over a period about five thousand years ago was under the ocean and at that time a channel which connected the Baltic directly with the North Sea and made it much more salt than it is at present.

It's waters today are not sufficiently salt to support oyster beds. The oyster shells left by the Paleolithic man in the kitchen furnished ample proof of its former saltiness. On both shores of the gulf of Bothnia the earth is rapidly rising from the waters. The coast of Finland possesses almost as great a proportion of lake surface as Sweden. In the entire region are abundant evidences of recent upheaval. In the course of centuries the gulf of Bothnia will in all probability become a lake and its connection with the Baltic be cut off by the line of rising islands between Umia and Wasa. At a later period the Ahmond

Islands with the numerous rocks and small islets will probably obtain a sufficient elevation to provide a bridge from Stockholm to Abo at the mouth of the Gulf of Finland. At the southern extremity of the Baltic the reverse phenomenon is found, and the coast at East Prussia and Pomerania is undergoing depression. Submerged forests on the shore testify to the rapidity with which the land has become submerged under the sea. Southern Denmark is also descending into the ocean. On the extreme southern end of Sweden the movement affecting all other portions of that country is reversed, and the rapid progress of the depression is seen in the partly submerged streets at Malmo and several other towns on its coast.

The entire coast of the North Sea west of Denmark is sinking. Holland has been gradually subsiding into the seas for centuries. The protection afforded by its Dykes is all that saves the lives of its inhabitants. A considerable point of its surface is below the sea level. On the French Coast the same phenomenon appears. A remarkable instance of the extent of the changes that have occurred is seen at Mont St. Michel in Normandy. In the early part of the Eighth Century the monks formed the monastery on an imposing rock that at the time rose out of the vast forest thirty miles distant from the sea. Today access to the peninsula of Mont St. Michel is at high tide cut off by the rising waters of the English channel. The Isle of Jersey was connected with the mainland up to the sixth century before the Christian era.

On the southern coasts of England unmistakable proofs are seen of its gradual submergence into the sea. Submerged forests and remains of destroyed towns are visible and tradition has woven a web of romance around their disappearance. In the northern part of Great Britain the island is however rising. The Roman wall of Antoninus in Scotland ends at a point twenty six feet above the sea level. At Cramond the walls of an ancient castle are twenty four feet higher than the ocean, which undoubtedly washed its base when they were built. The northern shores of the Adriatic have for ages been slowly subsiding. It has been estimated by Donati that the ground upon which Venice is built has sunk six feet into the sea since the foundation of the city.

At Spalatro and Tara on the eastern coast, Roman pavements have been found submerged beneath the waters of the Adriatic. At the eastern extremity of the Mediterranean Palestine and Egypt are being depressed. The Isthmus of Suez is also sinking a fact known to Strabo who predicted the ultimate separation of the continents of Asia and Europe, at that point in the course of centuries. In the lower part of the Red Sea the land however is rising and coral is forming in shallows created by the continued elevation of its bed.

Ever since classic times the coasts of Asia Minor have been subjected to an upheaval. In the revolt of Histriaeus and Aristagoras, against Darius, the Ionian galleys made an attack on the Persian fleet near the Rocky precipitous island of Lade, then lying a considerable distance off the coast. In the time of Alexander the Great, Lade was in all probability still an island, as it is so described by Arrian. Today, a hill, rising out of a plain on the banks of the Meander, several miles from the shore of the Mediterranean marks the place of the island. The gradual rise of the coast line of Asia minor has elevated the entire region and the alluvium brought down by the Meander has filled the

depression in the sea's bed. On the same coast the Latimicus Sinus, near Mount Latmus is described by Strabo, as one hundred stadia, or about twelve miles in length. At the present all that remains of this arm of the Mediterranean is an insignificant lake situated far inland.

In the Pacific Ocean the Sandwich, Tahitian and Solomon groups are rising from the sea while the islands in the intervening space are undergoing depression. Japan and the line of islands to the northward are rising. The strait between Nippon and Korea is extremely shallow and the transformation of the sea of Okhotsz, into a lake is an event foreshadowed by the changes going on. To the southward the Yellow Sea has a depth which does not exceed 240 feet. The opinion has been ventured that this Sea vast as it is has been created almost within the limits of historic times. The subsidence to which it owes its origin, was undoubtedly followed by an upheaval. This alternation of movement has been extremely unfortunate for the crowded population of the Chinese Empire. Thirty years ago the rising of the land on the shores of the Yellow Sea closed the mouth of the great Hwang Ho, and changed its course so that its waters were diverted into the Gulf of Pecheli, three hundred miles to the northward of its former entrance into the ocean.

The Chinese town of Pootai said by their annals to have been in 220 B.C. a seaport 140 li or 46 miles inland, a change partly due to upheaval and partly to accretion from alluvium. The assistance of the naturalist has been called for to supplement the more restricted geological methods adopted a few decades ago. The changes in the Earth's crust in the dim past may some times be determined from the similarity, or dissimilarity of the fauna and flora of contiguous regions. Great Britain was once joined to the continent, as is clear from the fact that that its trees, shrubs and animals are of the same species as those upon the main land.

The upward motion so apparent in the northern coast of Africa extends through Spain and Portugal and can be traced a certain distance to the north of the Pyrenees. On the Atlantic coast at the base of these mountains is a wide expanse of flat country, which ages ago, was at the bottom of a shallow sea, which then separated France & Spain. The district between Bordeaux and Bayonne, known as the Sandes, is today traversed only by French peasants mounted on stilts, a fact which indicates its formation. A comparison of the fauna and flora of the Iberian Peninsula and that of the countries to the northward of the Pyrenees shows a marked diversity. From this fact, the existence of a body of water disconnecting Spain and Portugal from the rest of Europe, could in the absence of all geological evidence, be determined from this contrast of species.

By means of similar processes of investigation, the conviction follows that the Mediterranean Sea exists by reason of a subsidence of the earth surface, that took place in comparatively recent geological times. Sicily, Malta, and other islands were undoubtedly connected at one time with Africa. This conclusion is reached from an examination of the animal and plant life of the North African coast, which allies it with Southern Europe and separates it by broadly marked characteristics from the fauna and flora of central Africa beyond the Great Desert. The region of the Sahara at one time disconnected north from southern Africa by a body of water that then rested upon its surface, but the question

whether it was salt or fresh, does not seem to be as yet determined. The resemblance between the animal and plant life on the Spanish peninsula and on the north African Coasts also sufficiently establishes the existence of a land connection, between these parts of separate continents, before the Straits of Gibraltar were cut through at a time when the Mediterranean was an inland body of water possibly divided into separate seas by tongues of land stretching north and south across it at points where the various islands are now found. A contrast between the flora and fauna of the greater part of Hindustan and Ceylon is proof of separation in former geological ages, in despite of the fact that at the present time, the island is almost connected with the mainland by a line of rocks rising out of the sea. The striking difference between the animal and plant life of Madagascar and of Southern Africa, indicates a continuous separation from the continent in all past eras. The resemblances between species and Madagascar and Ceylon with a connecting likeness to those in the Seychelles and other groups of islands, situated in the intermediate seas between these widely separated points, has given rise to a theory, not however generally assented to, that a great continent once existed in the Indian Ocean of which all portions except these extreme terminating points, have sunk beneath the waters, Borneo and Celebes are disconnected by a strait only nineteen miles in width. Alfred Russell Wallace found a marked difference between the forms of life on the opposite shores of this channel, a diversity which singularly enough was found to extend to the birds. The continuous existence of this separating body of water is announced by these facts. These islands belong to parts of different continents. Borneo as it is shown, by a similarity of species was originally a portion of the far distant Asiatic mainland. Celebes in the words of Wallace remains an enigma and possibly on this formed a part of a continent of which Australia and New Guinea are the fragments. The distinctly marked flora and fauna of New Zealand clearly define its place as a separate continent, in all geological periods, divided by a vast expanse of ocean from all other parts of the globe.

In the region of the Black Sea and the Caspian is found the most interesting area of displacement yet traced upon the planet. The Caspian Sea is a body of water about 770 miles in length by 430 miles in width at its widest part. It covers 180,000 square miles or about five times the surface of Lake Superior. On its eastern and southern shores the surrounding territory is arid and its drainage value slight. On the north it receives the Volga, which furnishes it with a water supply derived from an area of 527,500 square miles in European Russia and the Ural which delivers the rainfall on 85,000 square miles situated on the confines of Europe and Asia. The waters of the Caspian are salt, and it is simply an immense inland sea entirely disconnected from the ocean. Its level is eighty four feet below the Black Sea. On the watershed to the north of the Caucasus, and in the narrow strip of land between the Don and the Volga, the land has so insignificant an elevation, that it rises only twenty three feet above the level of the Black Sea. The Black Sea covers 172,500 square miles or a slightly smaller area than the Caspian. Its connection with the Mediterranean is through the channel anciently known as the Thracian Bosphorus. On the west its most important affluent is the Danube, which drains a surface of 300,000 square miles in central Europe. On the North West it receives the Dnieper draining a territory variously stated from 192,500 to 242,000 square miles and also the Dniester draining a region of almost equal size in South Western Russia. On the north east the Don pours into it a rainfall gathered on 170,000 square miles as in the

Steppes which are discharged through the Sea of Azoff and the Straits of Kertch anciently known as the Crimmerian Bosphorus. The supply from these rivers and from smaller streams in Asia Minor is so abundant that a strong current continually passes southward through the sea of Marmosa and Dardanelles into the Mediterranean. A striking contrast exists between the Black Sea and the Caspian. One overflows while the greatly reduced level of the other, in a region of salt covered plains, is a fact which at once raises the presumption that the rainfall it receives falls short of the evaporation.

The region of the Caspian has not yet had an examination thorough enough to determine many points required for a final decision on the questions it presents. Russian surveys have however furnished a certain number of interesting facts. Its flora and fauna have been studied with as comprehensive a result as could be hoped for, in so vast a field of observation. Enough has been gathered to fix the character of the great upheaval, which in prehistoric times brought about the changes in the Earth's surface which separated the Caspian Sea from the ocean. The Black and the Caspian were once united in an immense body of water to which the name of Ponto Aralean Sea has been given. Pallas, the naturalist who traveled through the adjacent regions in the years between 1768 and 1776 was the first to suggest the former existence of such a sea. It had no outlet to the South, the neck of land through which the channel of the Bosphorus is now cut was then intact. Its overflowing waters however found an outlet in the opposite direction, through a strait or possibly a much broader entrance, extending to the Arctic Ocean, then occupied the present Valley of the Obi and it's southwesterly confluent the Tobol. To the northward and eastward of the present limits of the Caspian, the Ponto Aralian covered a vast territory in Asia. It undoubtedly covered Lake Aral a body of water that now maintains a level of 158 feet above the Black Sea.

It has been supposed that it also connected by means of a strait through a depression in the surrounding highlands with Lake Balkast, that lies still farther to the eastward. The present elevation of Lake Balkast which lies 514 feet above the black sea affords a strong argument against the possibility of such an extension, but a local upheaval of the Earth's surface in the neighborhood may have greatly changed its conditions since the Ponto Aralian epoch. On the Ponto-Caspian Isthmus between Europe and Asia the great prehistoric sea washed the base of the Caucasus, while to the westward the mountainous region of the Crimean Peninsula rose at that time out of the waters as an island. This isolated condition of the highlands of the Crimea, continued down to historic times. Pliny describes the northern Crimea, under its ancient name of Taurica, as a dry land formerly covered by water. The Putrid Sea to the west of the sea of Azoff is the largest remnant of the overflow of the Ponto Aralian Sea now remaining. In the flat country of Southern and Central Russia, the limits of the Ponto Aralian Sea are largely undetermined and the questions involved call for extended observations over a large tract of territory.

In the far off geological past a connection with the Baltic may even have existed at a period when a comparatively small proportion of this land of northern Europe had emerged from the waters. The existence of a connecting period after the Ponto Aralian Sea had taken shape is not beyond the limits of a reasonable supposition. Shells peculiar to the Caspian have been found in the bed of the Volga as far northward as the Kama.

This point is 55° N. or about the same latitude as Koenigsberg, Moscow, and Nishini Novgorod. The full import of this statement can be measured by the fact that the vast plain which covers Northern Germany and southern Russia is so entirely level that between Cologne and Nishini Novgorod, a distance of 1450 railway companies have not met with any elevation that has required a tunnel. At the junction of the Kama the bed of the Volga is only 110 feet above the ocean level at the mouth of the Oka, three hundred miles to the westward, it has only reached an additional height of 80 feet. The headwaters of the Volga actually reach the department of Novgorod at a point less than 100 miles distant from Lake Ladoga and St. Petersburg on the Gulf of Finland. A very slight change in level is therefore all that is required to render credible the fancy of the imaginative Greek who described the return of Jason and the Argonauts from Cholcis, over a route by way of the Baltic.

A northwest extension of the Ponto Aralian Sea may possibly explain the fact that the beach has not extended eastward of a line drawn from Kingsberg to Odessa. Whatever its limits may have been, it certainly covered the region of southern Russia so completely that Volga, South of the Kama did not exist except perhaps as a [] extending northward between banks of insignificant elevation.

The destruction of the Ponto Aralian Sea was effected by the rising of the Earth's crust under different portions of its bed, at epochs possibly separated by long intervals of time. A very early displacement probably cut off all communication with the Baltic and an upheaval in northwestern Asia closed the channel leading into the Arctic Ocean. A relatively insignificant rise was perhaps all that was required to bring this change about. At the present time the land at the head waters of the Iobol river which flows into the Obi, is only one hundred and thirty six feet above the ocean level.

The intervening desert south of the Iobol, through which the Ural flows is a flat country, so that the slight elevation of the watershed of the Iobol is all that stands in the way of a communication between the Gulf of Obi and the Caspian, in a distance of fourteen hundred miles. Its northern outlet being destroyed Ponto Aralian became a land locked sea. The immense rainfall emptied into it by the Danube and its other great tributaries, soon forced a passage in another direction. After an increase of volume estimated at two hundred feet in depth over its surface, it broke its way through the isthmus which then afforded a land connection between Turkey and Asia minor.

A great body of water poured through the channel, thus made and by means of the Bosphorus, the sea of Marmara and the Dardanelles reached the Mediterranean. This stupendous event has been supposed to be the one known to the ancients as the Deluge of Deucalion. The axis of the great northern upheaval in Asia extended southward under the bed of the Ponto Aralian Sea until the land to the northeastward of the Caucasus rose out of the waters and the great sea became separated into two parts, of which the Black and Caspian Seas are the remnants. As soon as the separation took place the Caspian diminished greatly in size. It had lost its share of the immense rainfall from central Europe delivered by the Danube. Neither did it receive any longer the tribute of the Dnieper and the Dniester. What was still more important, a greater inclination in the

upheaval toward the Northeast threw the great volume of the Volga into the Black Sea, through the channel now occupied by the Don. It was clear that the Caspian was threatened with the usual fate of inland seas and lakes. The evaporation was largely in excess of the rainfall on its watershed. Its reduction in size must have been extremely rapid, a fact shown by the absence of intermediate marks of erosion between its original shoreline, when it was connected with the Black Sea, and its level today. The Volga remained an affluent of the Black Sea until the fifth century of the era, when a change in the elevation of the land directly to the north of the Caucasus turned its water through a new channel into the Caspian. Before the diversion of the Volga, the Caspian stood at a level fifty feet below its level today.

This is proved by the existence of the ruins beneath its waters at Derbend, a town on its western coast formed by Alexander the Great when he embarked at point on his expedition to India. Whether the Oxus or Annie Dana the great River of Central Asia has at any time emptied into the Caspian is a matter of great doubt. If the historical accounts are to be believed it originally was a tributary of the Caspian. It is further claimed that in the year 605 of the era, it was deflected into the Sea of Aral. According to the statements published in a French scientific journal in 1888, it was in that year returned to the Caspian by means of dams built by the Russian Engineers. It is asserted that an examination of the surrounding country forbids the belief that the Oxus ever entered the Caspian and that the deserted river bed to the eastward of the Caspian is one once occupied by the Marghab, a river rising in the mountains on the confines of Persia which at the present time is lost in the sands of the Desert of Khira.

If it is true that no indications are found, that the Caspian has ever received any considerable addition to its volume, with the exception of the accession of the Volga, belief could be the name easily given to this opinion. But if the Russian engineers have succeeded in diverting the course of the Oxus by dams, the historical relation becomes at least credible. Herodotus says that in his day the Jaxantis, or Syr Daria emptied into the Caspian. At the present time it certainly passes in to the sea of Aral. Great fluctuations in the level of the Caspian in the last century are recorded possibly based on popular report, but from the statements of the most careful observers it has not materially gained or lost in volume for several decades. There is little doubt however that the lakes in the country to the eastward of the Caspian are drying up rapidly. Lake Alyshkan which at the beginning of the century covered 530 miles of territory has shrunk until insignificant [] constitute the sole remains of its former greatness.

It is not believed that the Caspian is becoming more salt as is usually the case in bodies of water unconnected with the ocean. Its waters exhibit various degrees of saltness, according to the part of the sea from which they are taken. Strangely enough not very far from the mouth of the Volga on the opposite shore they are so salt that no forms of human life can exist. The average amount of saline matter in the Caspian is however much less than in the ocean. It is even less salt than the Black Sea, which receives so large supply of fresh water from the rivers that empty into it. The existence of a former connection between the Caspian and ocean is a well supported inference derived from substantiated facts. The oldest maps that have come down to us from the ancients

represent the Caspian as connected by a strait or arm of the sea, with the northern ocean. The general tradition from the earliest ages recorded by the historian and geographers in the ancient time was to the same effect. Herodotus exercising greater care and disinclined to put implicit faith in what he heard, probably took pains to ascertain the facts and described the Caspian as it existed in his time as an inland sea. It is a former connection with the ocean can however be established independent of all tradition. The polar fauna have been traced northward a great distance with the peculiarity that the frequency of their occurrence increases toward the Arctic Ocean. If no such connection ever existed, in what way can the presence of seals in the waters of the Caspian be accounted for.

The existence of seals of the same species in the Black Sea proves its former union with the Caspian in Ponto Aralian times. Nor can it be doubted that the connection of seas with the ocean was toward the north. It is clear that aquatic mammals like the Phocidae could never have found their way into the Black Sea from the Mediterranean. The seal is found in high latitudes only. Another channel of communication furnishes the sole possible explanation. The waters of the Caspian teem with herring, salmon and sturgeon. Their presence can be explained only by giving oceanic forms of life oceanic origin. Salmon are found in rivers but they go there for breeding purposes, and otherwise they constitute a species of sea fish not met with except where a connection with the ocean exists or has existed in the past. The finding of herring and salmon in the Aral is another proof of the existence of a Ponto Aralian Sea that imposed similar forms of life over a vast territory beyond the limits of the Caspian of today.

G. McLaughlin

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