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INTERDEPENDENT EVOLUTION OF OASES AND CIVILIZATIONS*

PRESIDENTIAL ADDRESS BY RAPHAEL PUMPELLY

(Read before the Society December 27, 1906)

CONTENTS

PHYSICAL DEVELOPMENT OF CENTRAL ASIA

The beginnings of central Asia, as part of the Great continent, lie far back in the Tertiary period, during a time when mother Earth was in travail, giving birth to her last-born, the new order of continental and organic forms. In the throes of the contracting terrestrial crust there had been slowly born great mountain masses, ranges whose ice-capped giants now mark the boundary between north and south, extending half way round the earth, through the Pyrenees, Caucasus, and Himalayas to China.

The Eurasian continent was born, but in its infancy a great sea extended from the Atlantic through the Mediterranean to southeastern

*The subject-matter of this address is the outcome of a careful analysis of some of the results of my expedition of 1904, under the auspices of the Carnegie Institution of Washington.

For the ability to use the pottery of the different cultures as characteristic fossils, I am indebted to the profound knowledge of ceramics of Dr Hubert Schmidt, the archeologist of the expedition.

In the physiography my son, R. W. Pumpelly, who made the surveys and studied minutely the natural records in the shafts, has contributed not only most of the observed data, but also some of the fundamental deductions.

Asia. Later, during the middle Tertiary, this connection was broken, leaving a great interior sea called the Sarmatic, which once extended from Austria to beyond the Aral.

In the progressive development of land and climate, during Pliocene or late Tertiary time, this sea in turn broke up into separate land-locked basins of fresh and brackish water, the deposits and faunæ of which are designated as belonging to the Pontic stage.

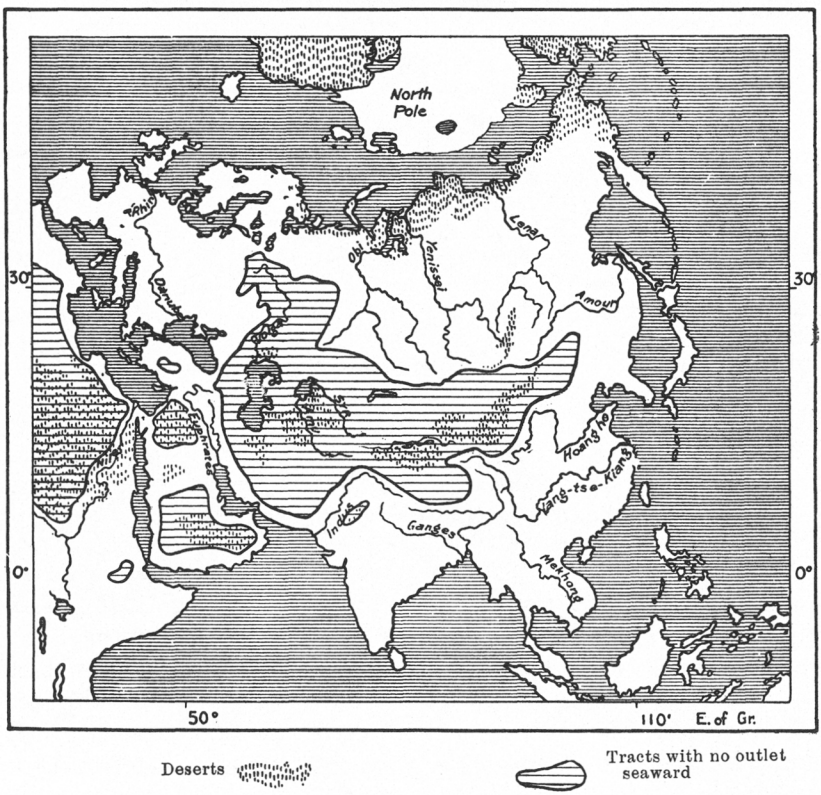

FIGURE 1.—*Arid Regions and closed Basins of Asia.*

From Elisée Reclus "The Earth and its Inhabitants."

In these changes we see the evolution of central Asia as an interior region. Differentiated from the periphery of the continent by mountains that intercepted the moisture from the ocean on the south, and otherwise climatically at a disadvantage on account of its geographical relation to the laws of atmospheric circulation, this vast region entered upon an independent course of development.

When this inner continental area ceased to send its waters to the ocean it was predestined to a course of evolution whose progress must inevitably culminate in the desert-waste conditions ruling there today.

Each of the geological periods mentioned had its characteristic land and water organic life, among which were prophetic ancestral forms in the genealogy of the mammals of today.

The cause of this differentiating evolution is as simple as it is fatefully majestic in its progress. The moisture, carried by the high currents of air in their course from the equator to the pole, is largely condensed in rising over the great altitudes of lofty mountain ranges. To the north of the highlands the plains receive but a slight annual precipitation, and this is so distributed in the seasons as to produce the minimum of vegetation in respect to the amount of precipitation received during the year.

Under these conditions a forest growth is impossible and the surface must be more or less grass-covered or bare, according to the amount of effective precipitation, which in turn may perhaps have varied during different periods with a possible varying in height of the intercepting mountains.

Under such conditions the region would vary in character between semi-arid and arid.

Whether semi-arid or arid, the hot air, rising from plains barren of vegetation and heated by the sun of spring and summer, prevents local rainfall, and the residuum of moisture that escaped condensation on the mountains is carried on to the colder regions of the north. It is only during the winter that this residuum is precipitated on the plains as snow, and even this melts away by March, awakening to life a varied desert flora, which in turn vanishes under the burning April sun.

Thus, excepting the relatively ineffective winter snows, the whole of this vast inner continental region receives waters only from the precipitation over the high mountains that separate it from the peripheral zone, and from such mountains as rise sufficiently high within its own area.

Central Asia from the western border of Manchuria to the western end of the Black sea is a series of great and small land-locked basins. From these no water flows to the ocean, excepting that which the Black sea loses through the canyon of the Bosphorus, which was not opened to the Mediterranean until the present geological epoch.

This great land-locked area is divided into two basin systems: one is the higher-lying Gobi on the east, inclosed on the west between the mountain masses of the Kwenlun and Tienshan.

The western system of land-locked basins covers a great part of western Asia. Extending west from the Tienshan ranges, it is limited on the south by the Persian plateau and the Caucasus and on the north by the low Siberian elevation that forms the water divide toward the Arctic ocean. On the west, from a hydrographic, but to a lesser extent from a climatic point of view, this system includes the Black sea, with the areas drained by the Volga, Don and Dneiper (a large part of Russia), and by the lower Danube.

The Persian plateau itself forms an independent high-lying system of arid land-locked basins.

Of this great western system a part near the Caspian sea lies below the level of the ocean. A large part of the whole system is so situated in reference to the barriers that separate it from the oceans that, given a sufficient quantity of water and the closing of the Bosphorus channel, there would be a land-locked sea several hundred feet deep and larger than the Mediterranean. It is potentially a sea, of which the Black sea, Caspian, and Aral remain as three larger residuary bodies of water. This is due to climatic conditions, under which the precipitation over the region, together with the water brought by the streams from without, is offset by the intense evaporation over the heated arid surface.

With a sufficiently long-continued inflow of water in excess of evaporation and a restoration of the barrier at the Bosphorus, the Black sea and the Caspian would coalesce and, after extending to include the Aral, would rise till an overflow should be reached, either into the Mediterranean or into the Arctic ocean, and our potential sea would become a reality.

If, on the other hand, there should exist a sufficiently long-continued condition, in which evaporation should be in excess of inflow of water, then a time would come when, instead of a sea, there would be only a region of barren deserts.

Our basin is, therefore, potentially both a sea and a desert. At present the two controlling factors—water and evaporation—are about in a state of equilibrium.

The existing residuary seas are therefore, in the rising and lowering of their surfaces, gauges recording the cyclical climatic changes as they occur over the great catch-basins that supply them with water.

Of these catch-basins the northern and western ones are the great hydrographic systems of European Russia and the smaller river systems, chiefly of the Caucasus. The rest lie almost wholly in the lofty mountain chains that stretch with increasing height and area as they go eastward to high Asia. The vast masses of snow and ice constantly accumu-

lating on these heights feed perennially the few larger and countless smaller streams that flow toward the central basin region. Without these, Turkestan would be an absolutely desert and practically lifeless region.

I imagine that the general trend of climatic conditions over the central continental area was from the beginning toward aridity. The mountains that separated it from the ocean were of slow growth, and mountains of moderate altitude are compatible with a moderate amount of precipitation over the interior region beyond them. The grassy plains of Mongolia and of our central western states are illustrations of this.

The early condition of Turkestan and northern Persia during much of Pliocene time may well have been one in which at first forests existed, at least on the piedmont hills and plains, while the rest of the region, that was not still occupied by the residuary seas, consisted of broad, grassy steppes extending to Europe and of interior areas of deserts.

Parallel with the growing elevation of the moisture-intercepting mountains progressed the regional desiccation. The progressive effect of this would be continued shrinkage of the water areas, conversion of much of the central plains into deserts, narrowing of the grass-covered zones toward the mountains, and change in the character and extent of the forested areas.

After the Miocene sea had been shut off from the ocean, it dried up, as is shown in the Sarmatic strata by the widespread deposits of gypsum and salts resulting from the evaporation or the saline waters. That the basin was reoccupied more than once by a more or less extensive land-locked sea is shown in successive formations characterized by changes in organic forms and by old beach and water lines.

There is little doubt that these expansions of the water area record the climatic changes that mark the advent and phases of the glacial period. An effect of these changes, which were of mundane extent, was doubtless an increase of precipitation over a larger part of the central region.

In the Glacial period a large part of Russia west of the Ural mountains was covered to a depth of several thousand feet by ice, a large part of which in melting went toward filling the central basin. Our exploration in 1903, as shown in the reports of Professor Davis and Messrs Huntington and R. W. Pumpelly, have proved the existence of several successive glacial epochs in the mountains of high Asia during the glacial period, and that glaciers existed on a greatly extended scale

throughout the mountains bordering the great basin on the south and east.

Each of these epochs of glacial expansion must have had its echo in a corresponding expansion of the water area and in a reaction on the climate of the basin region itself, in the direction of local precipitation and amelioration of the desert conditions.

During the glacial and interglacial phases of the Glacial period there must have existed a continuity of broad and perhaps alternately tundra and grass-covered steppes along the whole length of central Asia into Europe.

The great "Central" basin system resembles the ocean in that it is the sink into which all the solid and dissolved products of the destruction of the surrounding country are brought. In the ocean all such detritus is classified by gravity, wave action, and currents, which distribute the graded material over wide areas. On the dry surface of the desert plains this classification and distribution is begun by the rivers and finished by the winds.

While in the ocean the sand is deposited to become stratified beds of sandstone, and the clays to form ultimately beds of slate, in the arid basin the sand accumulates in moving hills and the finest silts are borne off by the winds to form the remarkable and economically important deposits of loess.

We have seen that the lofty mountains intercept most of the moisture brought by air currents from the ocean, and that the fiery column of air rising from the heated barren plains prevents precipitation except in winter; but there is a zone between the deserts and the mountains on which sufficient moisture falls in spring to nourish the grasses of a semi-arid region. In Mongolia, where the intercepting mountains are low, the zone is broad. In Turkestan it is narrow or in places now almost wanting. During the cold Glacial period it was wide.

I will ask you now to consider this central region as an organic whole.

Imagine yourselves, if you please, looking down over this great expanse and, foreshortening space and the vista back through untold centuries, able to view the successive phases of its life during a short period of geological time.

First, you are in the Glacial period. On the south you see the giant mountains, from the Caucasus to China, covered with snow and, on the higher masses, great domes of ice and far-reaching glaciers.

Far away in the northwest you see the cap of continental ice spread thousands of feet thick over nearly all of European Russia. Between these limits your sight wanders over the blue waters of a sea greater

than the Mediterranean and fed by the larger rivers that flow from the snow and ice capped regions.

You see the rivers building great deltas where they enter the sea, while above these they spread their silts far and wide over the aggrading plains.

Remember that while you look, in *your* time-perspective millenniums are as seconds. Even now the Glacial period has passed and the reaction has begun, and you see the beginning of a general trend toward desolation. The ice-cap is gone from Russia and the great glaciers on the southern mountains are diminishing in extent. Evaporation is now more rapid than inflow of water, and the sea is shrinking and breaking up into smaller basins. With each lapse of thousands of years you see the larger rivers grow smaller, while many of those coming from the southern mountains fail to reach the receding sea. Those great gyrating columns that are coursing the surface of the earth show that the dried silts have become the prey of the winds.

And now, if you will look closer, you will see at their work all the controlling agencies that are the life of the great geographic organism that we call an arid inner-continental region. You observe that the floodplains and deltas and the drying beds of seas are covered with dried silts of clay, sands, and gravels.

The winds are working these over and classifying them according to size of grain. The finest material is easily lifted and carried afar, and it is this that forms those massive yellow clouds that are darkening those plains in their progress, and those gyrating columns—vortices in the heart of the sweeping whirlwind.

Of the coarser silts the winds move only the sands, and these only slowly, along the surface of the plain where you see them, forming great seas of sand waves or dunes, in places more than 100 feet high. These waves progress as each high wind, lifting sand from the windward side, deposits it on the lee side. As the winds vary in direction during the seasons, so does the progress of the dust and of dune waves. But it is an important fact for us that both dust and dunes make an absolute progress during the year in the direction of the predominant winds.

Watch those columns and clouds of dust; as the wind falls, they disappear, settling on the surface to wait to be borne on the wings of the next wind-storm.

Look now toward the grass-covered plains bordering the deserts; no clouds rise from these; on the contrary, the volumes of dust that fall here, fall to remain under the protecting vegetation; the grass is nourished perennially by the dust, and under this reciprocal process the sur-

face rises slowly during the centuries to form great thicknesses of the soil we call loess.

Look back again over the region; while the sand from which was separated the dust you have just seen deposited to form loess lags still scores of miles behind in its advance, you see the grassy plains bordered by a sea of high and older sand dunes. They, too, have been arrested in their overwhelming progress by the slight growth of grasses and plants that are compatible with a soil of sand, under the slight precipitation near the border zone. Both the loess and the dunes grow continually in height.

You have seen a cycle of geological activity quite different from that which takes place on the periphery of a continent where the silts are distributed by ocean currents over great submarine areas.

Here, on the contrary, the waste from the degrading mountains, which was spread by rivers over the plains, is returned by the winds to pile up on the piedmont zone, and this is obviously true not only of the solids, but of the soluble alkaline and earthy salts as well.

All this conforms strictly to Richthofen's theory, that loess is a product of deflation of desert surfaces, wind-borne till it found protection on the grass-covered zone. Here, however, we see that water intervened as an earlier transporting agent, and that evaporation, on the plains, restored to the fine silts the salts that had been leached out. That loess may form without the intervention of water we have seen in the extensive deflation of rocks on the high deserts of the Pamirs.

Let us return to your panorama; it is still that of many thousand years ago, and the grassy steppes across all central Asia teem with herds of wild ruminants and horses and other animals that during early glacial and interglacial time were common to the Eurasian continent.

I will ask you to look, at the same time, toward the edge of the plains. At short intervals you will see streams emerging from the mountains through canyons onto the plain, where they spread out evenly over large fan-shaped deltas that slope radially outward from the apex at the canyon mouth. These are the delta oases, of which I shall have more to say.

Casting your eye along the southern border of the plains, from the Caspian sea eastward you see grassy loess-plains fringing the southern mountains and filling out the great embayments between the spurs of the Tienshan ranges in the east. But everywhere both these plains and the deltas are hemmed in by the sea of dunes.

During your foreshortened time scale your present glance sees the effects of later climatic oscillations. It is perhaps a period of diminish-

ing regional precipitation; the zone of vegetation narrows, the scant protecting plant life disappears from the dunes, and they advance over the edge of the loess belt and encroach also on the shrinking delta-plains. With a period of renewal of precipitation vegetation resumes its former area and the loess deposits expand over the dunes.

The processes which we have reviewed have been operating with fluctuating intensity since Tertiary time.

The maximum of intensity existed probably as a consequence of the Glacial period.

Glacial epochs were accompanied by swollen rivers with broad flood-plains, expansions of the seas with extensive marshes, and by great extent of loess steppes.

During interglacial epochs the conditions were reversed; and after the last Glacial epoch there began the general trend toward the present condition of aridity—a trend that was interrupted by oscillations, in some of which the aridity may have exceeded that of today; a process in which the seas, while responding to the oscillations, have in the main shrunken gradually to the volumes compatible with the present equilibrium between precipitation and evaporation.

Parallel with this progress toward aridity, under the diminished precipitation and lessening to disappearance of the ameliorating climatic reaction of the once expanded water areas, was the shrinkage of the loess zones. The grassy steppes, which had once teemed with life and permitted the distribution of ruminants and the horse across all Asia to Europe, gradually became broken up into disconnected areas by the increased intensity of desert conditions.

The expanding deserts cut off the connection between the faunæ of southern Turkestan and Persia on the one hand and those of Europe on the other, and allowed the evolutions of regional varieties; and there must have been a similar reaction upon the distribution of man.

After this, a continued progress toward extreme aridity advanced the desert sea of sands till its dune waves, rolling ever nearer to the mountain, completely submerged long stretches of the narrowed loess zone between the now restricted deltas at the mouths of mountain streams.

The teeming herds of ruminants and horses disappeared over vast areas, and life was restricted to the mountains and to the borders of the few remaining streams and the deltas.

When this stage had been reached, in early prehistoric time and long before the introduction of irrigation, the condition of southern Turkestan and northern Persia may be summed up as one of deserts relieved only by oases on the deltas at the mouths of streams emerging from the

mountains, or where larger rivers died out on the plains or entered the shrunken seas.

The Kurgans Excavated in 1904

The delta oases have been the home of man from early prehistoric time till now, throughout Turkestan and northern Persia. It was on one of these, at Anau near Askabad, 300 miles east of the Caspian, that I made in 1904 the excavations and physiographic studies, some results of which are the subject of this address. In the center of the delta oasis stand two hills, a half a mile apart, and the ruined city of Anau one mile from both.

These hills, or kurgans, consist of layers, the remains of human occupation—culture strata, we call them—that have accumulated during thousands of years of habitation.

They are the time-wasted, wind-and-water-carved remnants of long-forgotten cities. Together with the neighboring ruined citadel, they represent an almost continuous series of successive cultures whose local beginnings seem to antedate the dynastic remains of Egypt.

My shafts showed that these culture strata extend to a depth of 20, and in some cases to 28, feet below the level of the plain which has grown up around them.

Our excavations showed that the northern kurgan, which is 60 feet high from its base below the plain, is the older, and that the southern kurgan was not started till after the abandonment of the northern one; it has now a height of 72 feet above its base; and after this was abandoned the city of Anau started, and lasted till the middle of the last century, having grown to a height of 38 feet, of which 15 feet are below the level of the plain.

To try to find out why two kurgans, starting thousands of years apart, should have been buried to the same depth, I sank a series of over 20 shafts, both through the heart of the hills and on the plain.

I have time to give only such brief statements of the interesting results obtained from these shafts as bear directly on the subject in hand.

Culture Succession

To aid in this brief description of these ancient sites from an archeological standpoint, I have represented the leading results on the diagram shown in figure 2. There are present six successive cultures of distinct populations, giving a section from the present time down through the historic, the iron and copper stages, into the Stone age.

These are represented in 170 feet of culture strata still remaining out of an original aggregate thickness that has been much diminished by wind and rain.

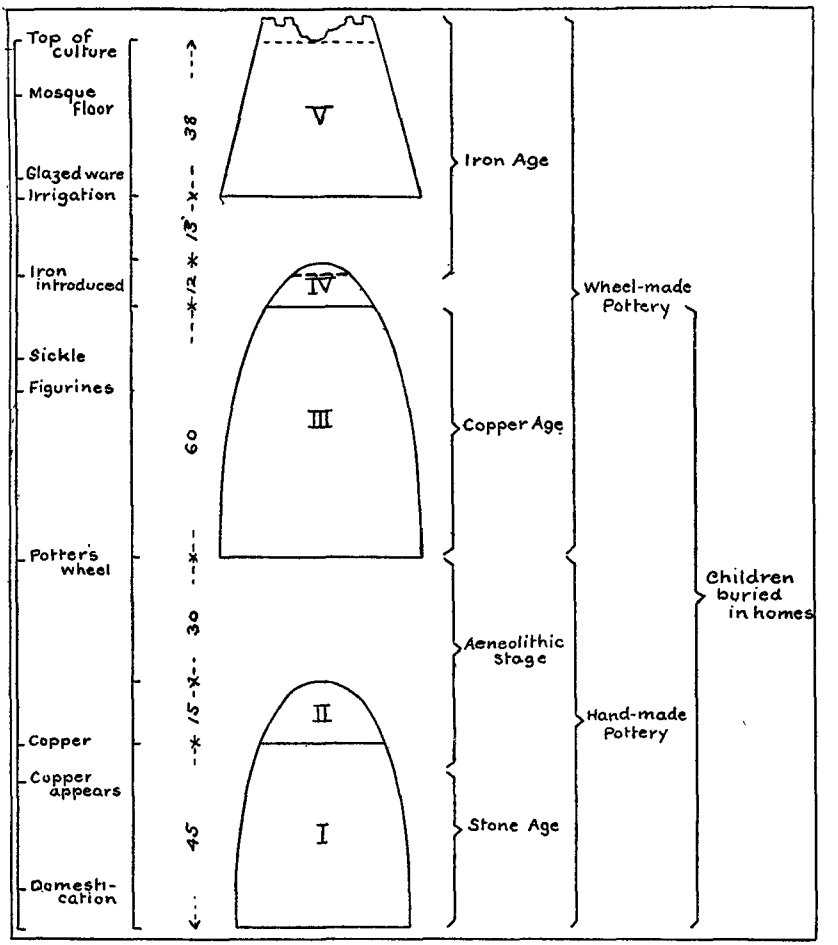

FIGURE 2.—*Diagram of the Successive Cultures at Anan*

I and II, north Kurgan; III and IV, south Kurgan; V, city of Anan.

In the diagram the three sites are represented one above the other, and intervals are left between them to represent the height each kurgan is estimated, as I will show, to have lost in the long lapse of time.

Already the oldest of these cultures appears here with a well developed pottery made by hand and a stock of geometrical designs which they

painted on certain classes of vessels. They had the art of spinning; and they baked, in bottomless bake-oven pots, bread made from material ground on mealing stones. They made knives flaked from flint, but they had no axes, spear heads, nor arrow points of stone, nor yet artificially formed sling-stones. They were hunters, and such weapons as they used must doubtless have been spears or arrows with points hardened in fire or tipped with bone.

In view of the importance that attaches to the question of the origin of our domesticated animals, I collected systematically, foot by foot from the bottom, all the bones of animals found in the older two cultures—that is, in the whole height of the north kurgan—and submitted nearly half a ton of these to Doctor Duerst, comparative anatomist and archeological osteologist at Zürich. He finds that during the growth of the lowest 8 or 10 feet of the kurgan the inhabitants knew only wild animals, and that out of these they domesticated the ox and the sheep, of which latter animal they in the course of many centuries established successively three breeds. He was able to trace the progressive changes in texture of bone substance and in the character of horns during the many centuries of progressive domestication. They appear to have domesticated the horse, too, but they imported an already domesticated pig and goat from Persia.

I will add that of these Doctor Duerst identifies assuredly one of the breeds of sheep and the pig with the domestic "turbary pig" and "turbary sheep" of prehistoric Europe, where the earliest remains of these animals found in the pile dwellings and other sites show that they arrived there already domesticated.

This is, therefore, the first discovery of the origin of domestication, and of the region from which the world derived the greater number of its useful animals.

This people was suddenly supplanted by a new one, with an entirely different pottery, still hand-made, but more developed, and with a different stock of painted ornamental geometric designs.

They had also the art of spinning, and all the indications are that they made their bread in the same way as their predecessors, and used flint knives. With them there appears the camel, probably the Bactrian two-humped variety, and a limited use of pure copper. While they made knives of flint, they, too, had neither axes nor spear or arrow points of stone or metal.

No succeeding civilization occupied this kurgan. The next arrivals started the neighboring settlement, which became the south kurgan,

and which, under their peculiar civilization, lasted enough tens of centuries for their remains to accumulate to a height of 60 feet.

They brought with them the potter's wheel and their own technique in pottery; and they had a full knowledge of the use of copper, and a knowledge of lead, which for some purposes they alloyed with copper. But they did not know bronze. Out of 23 objects analyzed by Professor Gooch, a ring and a small implement contained under 6 per cent of tin; a dagger, 1.58 per cent; another small object, 1.65 per cent. Excepting these four, all the others, including two daggers, two spears, an arrow point, a sickle, and a razor-shaped implement, were without a trace of tin.

All of the three cultures that I have mentioned had in common a remarkable burial custom: they buried children, and only children, under the floors of the houses, in a contracted position.

This people was finally succeeded by one in a low stage of culture, to judge from their coarse hand-made pottery; and they, in turn, were supplanted by a people who brought in the use of iron and a different pottery.

Neither these nor the barbarians who immediately preceded them buried their children in the houses. *The old order of related peoples and cultures was gone, and one showing wide connections was established.*

After this iron culture had left the south kurgan, the city of Anau was founded, and a modern system of artificial irrigation was introduced soon after the beginning of our era.

Relation of the Cultures to Their Environment

It is to the relation existing between these cultures and their environment that I beg now to call your attention.

You have seen how, with the slow trend of climatic change toward aridity, life-sustaining areas became gradually restricted to the desert-bound delta oases at the mouths of streams issuing from the mountains. I will now describe the manner of growth of these deltas and the relation of this growth to that of the culture strata, as we call the accumulated layers of the debris left by successive generations and by superimposed civilizations.

The first information obtained in this direction was from the shafts sunk at and near the south kurgan and shown on figure 2. We were fortunate in finding in these the data for calculating the relative rates

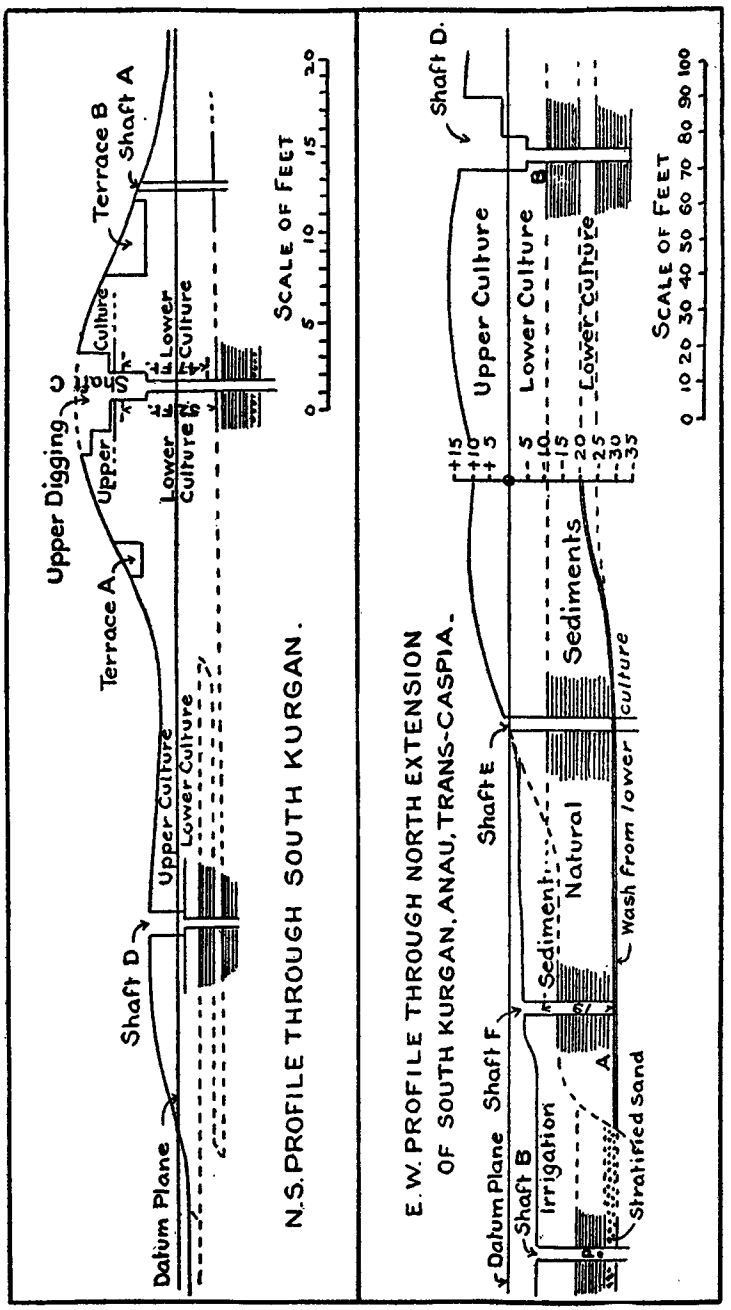

FIGURE 3.—*Sections through the South Kurgan.*
Reduced from the Survey by R. W. Pumpelly.

of growth of the sediments in aggrading the delta on the one hand and of the culture strata on the other.

By referring to the annexed profiles through the south kurgan you will see that a low plateau extends out from the main and high part of the kurgan. Now, while shaft C, sunk to the bottom through the heart of the high part, passes uninterruptedly through culture strata, shaft D, in the projecting plateau, after sinking through culture strata, enters natural sediments, below which it passes again through culture strata till it finds the base of culture at the same level as under the main body of the kurgan in shaft C.

As we recognize geological horizons by their characteristic fossils, so here we recognize the cultures to which these strata belong by the very characteristic pottery in which they abound. We find interbedded in the natural sediments in shafts E and F a layer of wash containing fragments from the same lower culture that was cut in shaft D. After the deposition of this pottery the natural sediments grew 19 feet in height, submerging the settlement and rising to the level at which it is covered by culture strata in shaft D, which is 16 feet below the beginning of the pure iron culture.

Now, the evidence in shaft C is that the main body of the kurgan grew uninterruptedly from its base 52 feet, to reach there the level, 16 feet below pure iron culture. If we assume that these 19 feet of sediments began to grow contemporaneously with the founding of the kurgan, the relative rates of growth would be $52/19 = 1 : 2.733$.

It is possible, however, that the whole thickness of the 7 feet of submerged culture strata contributed to the layer of "wash" with pottery in shafts E and F; therefore, if we subtract these lowest 7 feet of culture strata shown in shaft D from the 52 feet in the main body of the kurgan, we have the rates: $45/19 = 2.368$; say, 2.37. But, everything considered, it would seem proper to take $1 : 2.5$; that is, 1 natural sediments to 2.5 culture strata as the relative rates of growth.

This ratio being obtained from the parallel accumulations of a considerable period of time has, as we shall see later, for our purpose both an archeological and geological value.

After the sediments had reached the height shown in shaft D, there came a change, and this part of the plain was dissected; for, a little farther eastward in shaft B, we find a new series of sediments marking a renewed aggrading.

Now, when this new growth had reached the level indicated by a dot below the letter P, in shaft B, it received fragments of the pottery pecu-

liarly characteristic of the uppermost or iron culture of the kurgan; and from this level it continued to grow upward a further 7 feet, after which irrigation was introduced. Now we have archeological and stratigraphical evidence that the introduction of artificial irrigation was about contemporaneous with the founding of the city of Anau and the abandonment of the south kurgan.

Our ratio, 1 to 2.5, is equivalent to a growth of 17.5 feet of culture strata between the time of deposition of the iron-culture pottery in shaft B and the apparently contemporaneous ending of the life of this culture and the beginning of irrigation, while there are only 4 feet of iron culture now standing on the top of the kurgan. The great deformation that this hill has suffered is evidence that it has lost a considerable amount of its original height, and it is likely that the difference between the 17.5 feet of iron culture required by our ratio and the 4 feet now standing is a proximate measure of that wastage. I have therefore, in the column of cultures, added this 13½ feet to the present thickness of culture strata of the south kurgan; and since the time of abandonment of the north kurgan is separated from us by nearly three times as many centuries as that of the south kurgan, I have added to it 30 feet to represent the culture strata wasted by wind and rain.

Let us turn now to the shafts at the north kurgan. Here in shaft I, 200 feet west of the kurgan, we found a wall and hearths and lower-culture pottery at a depth 8 feet deeper than the base of culture in the kurgan. The conditions showed that the settlement was started on the side of a valley which had dissected the delta-plain. Several hundred feet farther west, in shaft II, we could trace the progress of refilling of the valley, for, at the same level as the deep culture in shaft I, we found here pottery of the lower culture. This pottery characterized the upward growth of the strata during 8 feet. At this level the association of upper-culture pottery, charcoal and bones, as well as their conditions, indicate that the aggrading had ceased.

The sediments above this pottery seem to belong to the latter aggrading, which submerged the early culture at the south kurgan.

Change-producing Agencies

Let us now consider the agencies that have been active in these processes of cutting down and rebuilding. They form one of the most interesting illustrations of the law of compensation in the grand cyclical action of forces that have modeled the relief of the surface of our planet.

A great mountain range, several hundred miles long, forms the sharply defined southern edge of the desert plains of eastern central Asia. It rises everywhere abruptly from this plain to a height of from 5,000 to 10,000 feet, and its height is sufficiently great to cause it to receive abundant precipitation and a heavy covering of winter snows.

Within this mountain system the trunk valleys, after following a longitudinal course, turn sharply and, cutting through the border range and piedmont hills, debouch their waters onto the plains.

The mountain masses, lacking the protection of a heavy forest growth, are subjected to rapid disintegration and decay, and the resulting detritus is carried by the torrential rivers down to the plains.

In a coastal region these waters would flow onward to the ocean and the silts they had brought from the mountain would ultimately complete the same course, to be deposited at the mouth of the river, to form there a submarine delta; but in an arid "central" region, such as is Turkestan, the conditions are different. The precipitation is confined to the mountains, and on leaving these the rivers immediately spread out in a region of rapid evaporation, where there is no compensating rainfall, for the valley ends at the mouth of the mountain gorge.

Thus all the coarse and fine materials brought by the torrential rivers from far and near in the mountains are deposited within a zone along the edge of the plain at the base of the Kopet range. The rock-mass of the mountains is therefore being continually removed and loaded onto this long zone.

Now two connected phenomena result from this process: on the one hand, the zone of deposition is continually and proportionately sinking under the increasing load, and on the other hand the mountains are continually rising to maintain their height.

The strain established in the rigid crust between the sinking zone of deposition and the rising mountain range finds relief in the development of fractures along the range, as well as others which permit a differential uplifting of great block-masses. The evidence of this compensatory maintenance of hydrostatic equilibrium is strikingly recorded both in the Kopet range and in the zone of deposition. All along the range the lines of fracturing are visible on a large scale in well developed faultings, and the border of the alluvial plain is bent sharply upward, having been dragged up by the rising mountains.

Deep longitudinal valleys are carved by erosion along the lines of weakness offered by these fault-planes. On the mountainward side of the valley rise the older rocks of the range, while on the other is a steep

wall, formed often by the basset edges of beds of conglomerate which are the up-bent representatives, near the mountains, of the alluvial strata of the plains.

On the other hand, the sinking of the zone of deposition is proved in the deep artesian well southeast of Askabad. This boring remained to a depth of over 2,200 feet in a pure delta formation, and was still in this when boring was stopped, at a depth of about 1,400 feet below the level of the ocean.

The delta is broadly divided into three zones of deposition: That of quickly dropped coarse detritus at the apex; the main body of the delta, the rapidly descending broad surface of which receives sediments from the overflow during the floods; and the outer, more or less flat, border, which receives both the finest material and any of the silts that escape with the water that in flood-time finds its way, to be lost beyond on the bordering plain.

This bordering zone belongs not only to the delta, but to the desert as well; and it is here that is waged the eternal struggle between the desert, with its breath of fire and its overwhelming sea of sand on the one hand and the life-bringing waters on the other.

The sands from the desert encircle the whole delta with a wall of great wave-like dunes. That they do not bury it is due chiefly to the slight growth on them of grasses that arrest the action of the wind, while the smaller amount of sand that reaches the delta is distributed by the aggrading waters.

The delta streams maintain channels through these dunes, by which the excess waters of the floods find their way, to spread out among dune-locked depressions, where on evaporating they leave their clay sediments to form the takyrs or adobe flats.

The continued process of aggrading on the three zones of the delta is, therefore, of a complex nature and dependent on varying factors: At the apex, there remains the greater part of the coarsest material, boulders, cobble, gravel, and coarse sand; the middle zone receives in overflow much of the finer silts, while the rest of the finest silts accumulate on the lowest slopes as far as the dune-barrier; and here, too, as well as beyond in the dune-locked depressions, are deposited the coarse and fine sediments rolled along its bottom or carried in suspension by the stream.

Parallel with the contribution from the mountains is that from the boundless desert on the north. As we have seen, a part of the sand from the desert is distributed and assimilated by the living delta. Besides this the desert whirlwinds come laden with fine dust, and where this falls

on the delta it remains caught in the vegetation and it, too, enters as a loess constituent into the delta structure.

Of the two essential factors—mountain-rising and precipitation—we may, I think, take the rising of the mountains to average a constancy adequate to the maintenance of a relatively constant grade. On the other hand, we will probably be right in dealing with considerable periods of time, if we assume that precipitation is a factor of more varying intensity. It is evident that, other things remaining equal, the amount of detritus brought from the mountains will be proportionate to the amount of precipitation to supply the volume of water needed to move it.

After this detritus emerges from the mountains, the manner in which it builds up the delta depends largely on the relation between the secularly maintained volume of water and the established grade.

The tilting of the edge of the plain favors erosive action and deepening of the channels of

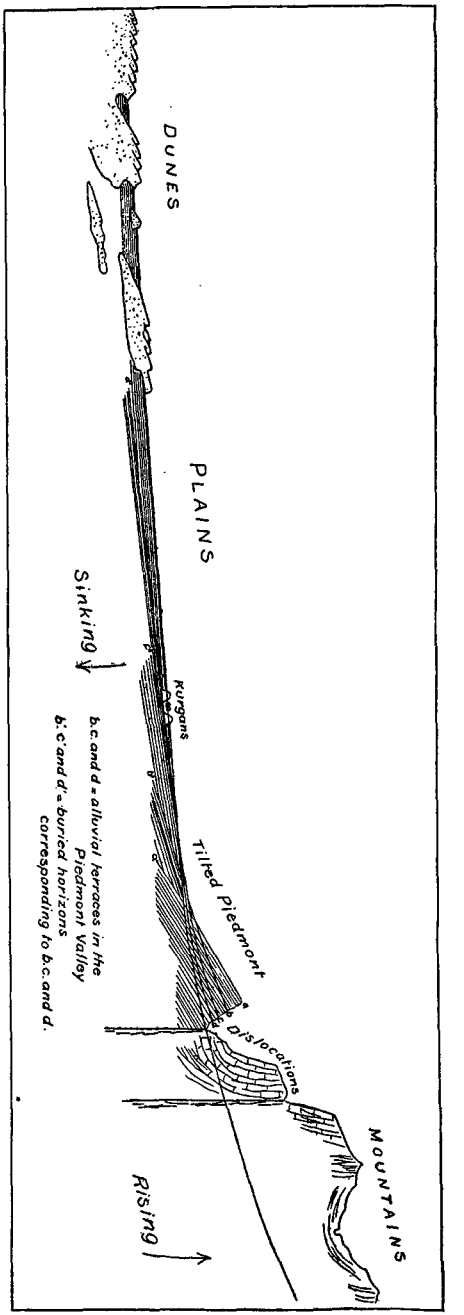

FIGURE 4.—*Partly idealized Section through the Oasis of Anau.*

Illustrating the effect of tilting along the margin of the aggrading planes of Turkestan. By R. W. Pumpelly.

watercourses across the deltas. Such a channel having been established across a delta, all the material that is not dropped on account of its coarseness at the apex near the mountain is carried onward. Where the floods can overflow the banks, they deposit silts on the general surface; but the greater part of the detritus carried goes to the gently inclined and dune-barred foot-plain of the delta, where it spreads out, forming an alluvial plain around the lower slope of the fan. We may call the upper edge of this aggrading plain the grade-contour line of alluvial shore. The mouth of the valley will always be at this shoreline and move with it upstream or downstream.

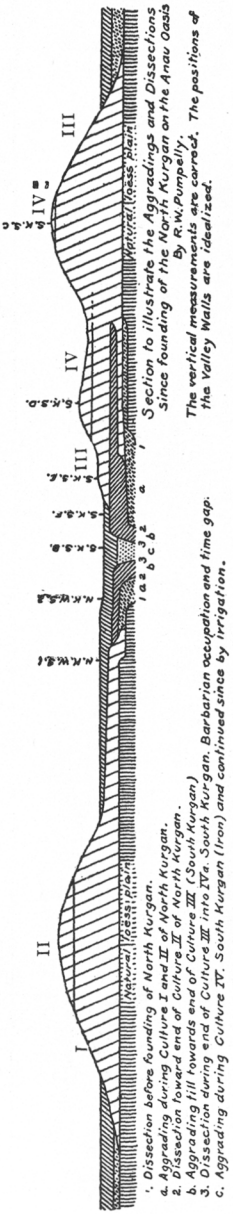

FIGURE 5.—Section to illustrate the Aggradings and Dissections since the Founding of the North Kurgan at Anau

I. First culture. II. Second culture. III. Third culture. IV. Fourth culture.

Border-tilting remaining the same, this alluvial shoreline moves up and down along the delta slope, according to the fluctuations in precipitation. The greater the volume of water and of its silts, the more rapidly will the alluvial plain be aggraded, its shore be moved up the delta-slope, and the tilted piedmont valley be obliterated in its lower stretch.

A sufficiently long continuance of these conditions will aggrade the whole delta, covering it to its apex with a shell of alluvial strata, and the valley will be wholly obliterated; the surface of the delta will now become the floodplain of the stream and the aggrading will now occur over the whole surface from the apex downward.

On the other hand, with a sufficient diminution of precipitation and of inbrought silts, mountain-rising remaining constant, the stream, untrammeled by excessive load, will again work at cutting a channel; agradation will be at cutting a channel; aggradation will be channel mouth, move to the foot-plain or beyond, among the dune-locked basins of the desert; aggrading will be continuous below the zone of oscillation of the alluvial shoreline.

Let us now apply these principles to an interpretation of the facts observed in the shafts at Anau in their bearing on the history of the prehistoric settlements.

The cutting down of the valleys, observed there would represent periods of lesser precipitation, and the refilling would mark periods of increased precipitation.

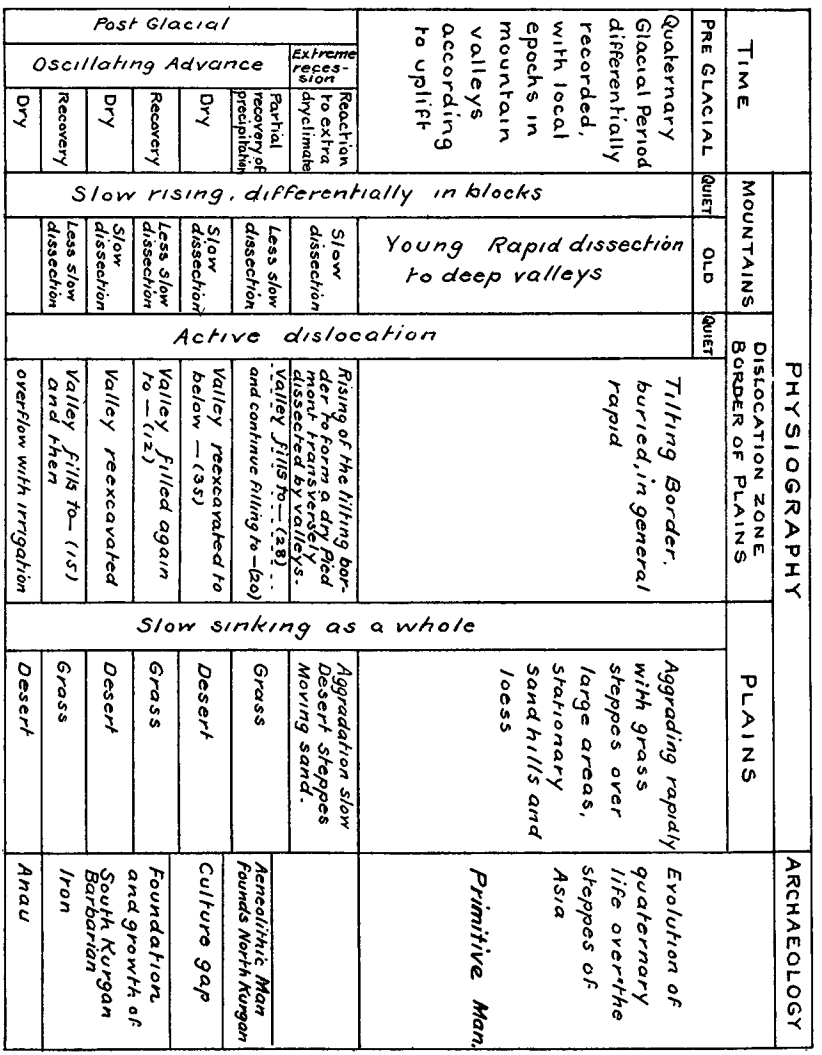

FIGURE 6.—*Tentative Correlation of Human and Physical Events during Quaternary and Recent Time.*

The information obtained in the shafts is brought together in figure 5, in which the essential facts are represented correctly in the vertical scale, while in the positions of the valley walls are necessarily idealized.

During a dry period preceding the founding of the north kurgan, a valley had been cut in the delta-plain, the surface of which dated from loess-forming time.

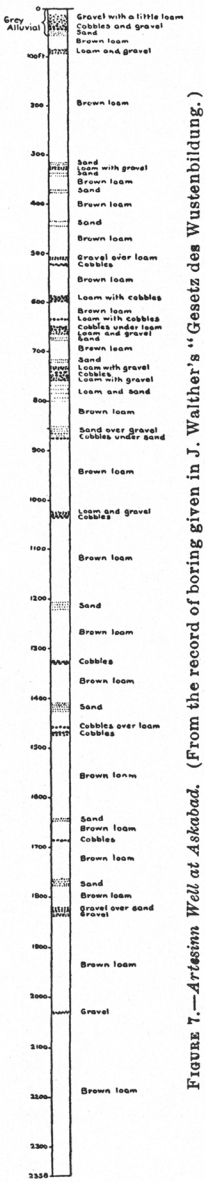

FIGURE 7.—*Artesian Well at Askabad.* (From the record of boring given in J. Walther's "Gesetz des Wustenbildung.)

Then came a period of increased precipitation, during which the valley was refilling during the life of the oldest culture and into that of the second.

During part of the second culture—the latter part of the life of the north kurgan—there recurred a dry period during which the valley was reexcavated. When, under renewed precipitation, it began to refill again, the south kurgan was started on the west side of the valley, on the orignal loess-plain. This growth of sediments continued till it rose higher than the previous aggrading, overflowing not only the terrace of this and the general plain, but also a part of the earlier culture of the growing south kurgan; and it continued to grow until the flourishing period of the life of this kurgan was drawing to a close, at a height of 52 feet above its base.

Then followed again a change to dryness, causing the reexcavation of the valley and lasting through the life of the supposed barbarian occupation.

Again a reverse change caused the refilling (shaft B) that followed, which lasted till the introduction of irrigation, and this period of refilling coincided with the life of the Iron culture.

The coincidence is thus very marked between the founding and growth of cultures and the conditions of precipitation that permitted the aggrading of this part of the delta; and equally well marked is the relation between the dry periods and the disappearance of cultures.

In the accompanying table, figure 6, R. W. Pumpelly has attempted to correlate the march of human and physical events during Quarternary and recent time.

The record in the Askabad well (figure 7) is very interesting, for it gives a section extending 2,300 feet down in the zone of deposition and depression. Below the upper 60 feet, with the exception of layers of coarse material aggregating less than one-tenth of the volume, it consists uniformly of a

brown loam, which indicates clearly that loess-dust enters into it as an important constituent. Of the upper 60 feet, 50 consist of more or less coarse material in which the brown loam is absent.

The conditions that permitted the forming of these great thicknesses of brown loam were apparently those belonging with a greater amount of both general and local precipitation. They presuppose, I think, a degree of moisture that does not now obtain, under the influence of which there was a perennial growth of grass sufficient to allow the growth of intimately mixed alluvial silts and loess-dust.

Of the upper 60 feet of this column, 50 feet consist of more or less coarse material without brown loam, and I imagine that the top of the brown loam at —60 feet in the well is proximately contemporaneous with the similar material under the north and south kurgans, and that its greater depth may roughly correspond to the depth to which degradation extended before the refilling of the valley occurred, during which the north kurgan was started.

The absence of the brown loess-dust constituent, both from the upper 60 feet in the well and in the sediments deposited at Anau after the starting of the north kurgan, points, I think, to a diminished precipitation over the piedmont zone; that is, diminished sufficiently to cause a deficiency in the growth of grass required to retain the loess-dust.

When we compare, further, the upper 60 feet in the well with the whole of the column below, we see that there is evidence of a great change from a long-continued different condition; and when we consider together the apparent decrease in vegetation indicated by the absence of the loess constituent, and the evidences, both geographical and archeological, of regional desiccation, the change would seem clearly to have been toward aridity. The successive degradation and rebuildings recorded in our shafts show that this period was one of fluctuating climate—a time in which the periods of greater precipitation affected the mountain regions without causing local rainfall, after winter, on the zone of deposition.

The time needed for the accumulation of the observed 2,300 feet of sediments in the Askabad well can be estimated only in geological chronology. It doubtless extends well back in the Pleistocene period, and it is not unlikely that the conditions shown in frequent recurrences of coarse cobble-beds between the depths of 500 and 900 feet mark the last great glacial advance.

Looking on the loess-forming condition shown below —60 feet as typical of the piedmont plains of southern Turkestan generally and

probably of northern Persia as well, we see correspondence with the conditions that permitted the existence of the herds of ruminants and horses that in Pleistocene time ranged from Mongolia to southeastern Europe; and that these animals existed in a wild state at Anau at the time when the north kurgan was settled is proved by Doctor Duerst's study of the bones collected during our excavations.

Introduction of Irrigation

If we look at the present climatic conditions ruling throughout Turkestan, we find that irrigation is now almost everywhere essential. The only exceptions are the high valleys and the piedmont borders of the more lofty ranges.

At a few points, as near Samarkand, grain is planted on the mere chance of there coming once in two or three years enough rain to mature a scanty crop; but along the piedmont plain of the Kopet range there is no local precipitation after March.

The arid extreme of the climatic fluctuations, which coincided with the disappearance of the different cultures of the kurgans and seem to have caused these interruptions, were very probably less dry than is now the case, but they were doubtless sufficiently severe to render the previously practiced system of agriculture useless for the maintenance of population and of domestic animals.

Not until the introduction of the artificial distribution of water was it possible thenceforth to maintain a continuity of civilized life.

The introduction of irrigation reversed the order of the delta-building processes. By bringing all the water under control through the season in which it carries sediments and distributing it evenly over the delta, the aggrading shoreline was kept back at the apex, instead of receding toward the desert, and the delta was continually built up over its whole extent. That this has been the case ever since irrigation began is shown by the fact that since the first layers of irrigation sediments were deposited over the old channel shown in shaft B, there has been no recurrence of dissection.

Had irrigation not come to the rescue, the aggrading shoreline would have receded desertward and the prolonging channels would have carried the sediments onward to form barren takyrs, or mud-flats, on the dune-covered plain.

Since the greater part of the fine sediments brought from the mountains is now retained on the delta, the rate of growth of the irrigation

formation is more rapid than was that of the natural sediments observed in the shafts. At present our only way of estimating this rate is by comparison with that of the accumulation of culture strata. Both the city of Anau and the irrigation formation started on the natural surface of the delta; and, while in the city the culture strata have grown to a height of 38 feet, the irrigation formation has risen on either side to a thickness of 15 feet, which would give a ratio of 1 of irrigation to about 2.5 of the culture strata of the city of Anau, which accumulated more rapidly than those of the kurgans.

Chronology

The greatest interest centers, naturally, in the problem of the age of these different cultures, and in their relation to the origin of Western civilizations, if any relations may be shown to exist.

The wide geographical separation between Anau and the fields of Western cultures and the paucity of objects found by us that recall in a definite manner similarities to objects of external civilizations surround the subject with the greatest obstacles.

Any treatment in the direction of proximate dating of any one of the cultures of Anau or advancing a general chronological scheme can be at the best only tentative and can serve only as a working hypothesis.

Such a working hypothesis has gradually formed itself in my mind and is developed in the following pages.

To begin with, I assume—

First, that distinctive pottery, peculiar to a culture throughout our successively superimposed earth layers, is evidence of corresponding continuity of that culture.

Second, that since it is a fact that throughout the lives of our sites at Anau the towns were built only of air-dried bricks, the secular rate of growth of culture strata can be taken as proximatively uniform.

Third, that two separate sites, whose cultures are characterized by entirely different and peculiar potteries, can not exist contemporaneously for centuries in close proximity to each other without such an interchange of pottery as would come to light during the excavation.

This is applying to archeology the rules of geological reasoning.

We know the thickness of the strata of each of the cultures of the three neighboring sites and we know the aggregate existing thickness of the cultures of each of the sites.

If we take the duration of each culture to be proportionate to the thickness of its accumulated strata, the duration of the entire series will

be represented by the aggregate existing thickness of all the strata plus any time-gaps between different cultures and minus any overlaps of the cultures of the neighboring sites.

In figure 2 I have arranged in one column all the cultures of the two kurgans and the city. In doing this I have represented the two time-gaps already mentioned by the equivalents in culture growth, obtained by using the ratio of 1 sediments to 2.5 culture strata, as already mentioned.

Having established in the column the deduced aggregate thickness of the culture strata, the next step is to find means of determining the secular rate of growth. This would be a relatively simple matter if our column represented culture sites on the Mediterranean, for in that case there could not fail to be many objects scattered through it that could be easily dated in the light of Western archeology.

In remote Transcaspia it is different. The evidence must, in the first line of reasoning, be internal, and in the present state of our work we have few data of approximate value.

In the shafts sunk in the city of Anau there was found glazed pottery continually down to a level of 5 feet above the bottom of culture. Now no authenticated finds of this ware had occurred in the kurgans, excepting in the surface debris of the uppermost strata of the south kurgan, where they might owe their presence to having been left on the former surface at any much later time.

In the main part of the ruined city of Ghiaur Kala, in Old Merv, fragments of glazed pottery were found by us down to a depth of 20½ feet, where they were associated with Sassanide coins of the third century A. D., and below which depth they were not found.

On the strength of this evidence, glazed pottery would seem to have been introduced into Merv not earlier than the third century A. D.; and since, in so far as the evidence of the three shafts in Anau city goes, it first appears there at 5 feet above the bottom of culture, we may assume that its introduction into Anau, which was also under Persian rule, was no earlier.

Its appearance at Anau is accompanied by a change in the ordinary pottery, slightly glazed light greenish ware partially superseding the hard-baked red ware of the lower five feet.

It would seem proper to ascribe these innovations to some important historical event. Now the mullahs told me that Anau was fortified by Nu-shirvan (Chosroes I), whose reign, 531–579 A. D., was the most brilliant period of Sassanian rule. In 557 he made his campaign against the Hephtalites (White Huns) and strengthened his outposts against the

attacks of these nomads of the northeastern plains, and it was probably at this time that he fortified Anau.

I think we shall be on the safe side in dating the introduction of glazed ware in the middle of the sixth century A. D., and in assuming that it was introduced into Persia from its home in Mesopotamia.

There are 33 feet of culture strata overlying the lowest appearance of this ware, and these ceased to accumulate in the middle of the nineteenth century A. D. This would give a rate of 2½ feet per century. That this is not making the rate unduly slow appears from another comparison. The superb mosque at Anau was built in 1444, as stated in the Kufic inscription of its façade. Its floor stands 9 feet lower than the top of the culture strata of the city, which would give a rate of 2¼ feet per century. If we apply the rate of 2½ feet to the whole of the 38 feet, we obtain the middle of the fourth century A. D. for the date of the founding of the city.

The culture strata of the city are of very loose texture; those of the upper, or iron, stage of the south kurgan are considerably less so, while the rest of the south kurgan and all of the north kurgan are very closely compacted. I have for this reason taken a rate of 2¼ feet per century for the period between the top of the copper culture and the founding of the city of Anau and 2 feet for the rate from the end of the copper stage of the south kurgan back to the founding of the north kurgan.

Using these rates, we may establish tentatively the following approximate dating of the essential events:

Founding of Anau	about 370 A. D.
Beginning of Iron culture	in fourth century B. C.
Founding of south kurgan and introduction of the potter's wheel	about 3750 B. C.
Base of upper (aeneolithic) culture of the north kurgan	about 6000 B. C.
First domestication of animals, beginning with the long-horned ox out of *Bos namadicus*	about 8000 B. C.
Founding of north kurgan	about 8250 B. C.

The deduction that the plain below the alluvial shoreline has aggraded at least 65 feet during the past 10,000 years has an important bearing on the limitations of archeological discoveries, not only in Turkestan, but also in all aggrading regions of a similar character.

It is evident that within the zone of continuous aggradation any sites older than the north kurgan must be buried out of sight unless they had been occupied long enough to rise to a height of at least 65 feet.

It will be interesting also to make a tentative application of the chronological data given in the tables to the strata of alluvial growth penetrated in the Askabad well.

The rate of growth of the delta alluvium is 0.8 feet per century as compared with culture strata at 2 feet per century.

An inspection of the record of the boring reproduced on figure 6 will show that between the depths of 500 feet and 1,680 feet the strata of sediments coarser than silts are of the coarsest kinds—large cobble—the long interval between 500 feet and 1,680 feet differing in this respect wholly from the rest of the column, both above and below.

There can be little question, I think, that the extremely coarse character of these beds and the frequency of their occurrence in this part of the column indicate for this interval a correspondingly long period of increased precipitation, during which the swollen streams were enabled to carry the coarsest constituents of their load farther down their channels, while lateral overflow spread much of the finer silts over the delta-surface.

It is likely that this part of the column records some of the phases of the Glacial period. It is also possible that the sediments between 320 and 1,820 feet grew more rapidly than those of the rest of the column, and that our deduced ratios are applicable only to the upper 320 feet, or to the growth of the last 40,000 years.

Turkestan and Irania, a Region of Independent Ethnic and Cultural Evolution under Isolation, dating from Preglacial or Interglacial Time

In considering the observed data of the earliest of the Anau cultures in their ethnographic relations, one must be struck by a singular fact: *They had none of the usual weapons of offense and defense;* the cores from which they made the abundant flint knives arouse our wonderment at the absence of the *arrow-points, spear-heads, and axes* found in almost all advanced Stone Age and neolithic settlements, as well as of maces and artificially formed sling-stones. Now axes, spear-points, and arrow-points of stone are, throughout the rest of the world, everywhere abundant where primitive man has existed, and in the improvement in the manner of their fashioning they serve to mark off the long stages in the slow development of primitive human culture.

The evolution of these implements from the almost natural shape to highly finished forms, specialized for different uses, was exceedingly slow. This has been proved at several points in Europe, where they have been found in strata of different epochs of the Glacial period and

intimately associated with undoubtedly contemporaneous animals of those epochs, and in all cases the progress in time is paralleled by the improvement in workmanship.

So true is this considered to be, that in studying these successive stages, glacial and interglacial, in Europe, of the Glacial period, the evolution of forms and of workmanship in the stone implements, when such are found, is only second in value to the bones of those animals with which the implements are associated and which mark the long oscillation between subtropical and arctic climates.

The early use of stone as a tool and the slowly developing inventive faculty at last rendered possible the manufacture of finely formed axes and spear and arrow points. These were acquisitions that stood casually and first in human development, in the same order with the discovery of the use of metals, powder, and steam.

It is not conceivable that a people who had once possessed this acquisition and had used axes and arrow-points and spear-points of stone could have lost the advantage these offered. This would be still more remarkable in the case of our Anauli, who, though settled in communities, still hunted wild animals and who had quartzite close at hand, as well as the flint of which are found the knives in such abundance and the cores from which they were flaked.

I see no way of accounting for the absence of these forms of implements and weapons except on the hypothesis that the ancestors of this people had become absolutely isolated from the rest of mankind at a period so remote as to be before the invention of these forms and perhaps even before the use of stone as a tool.

And they must have remained without contact with peoples among whom these implements and weapons were in use.

The next and necessary deduction under this hypothesis is that the whole of their culture is autochtonous, in the sense that it received no impulses from outside the people or circle of peoples so isolated.

It presupposes an early separation of a great inner continental region from the rest of the inhabited world.

I imagine that the cause of this separation is to be sought in one of the stages of the Glacial period, when the region, considered as a whole, became isolated as far as human intercourse was concerned. Moreover, after this it probably took a long time for the reaction from the conditions induced by the ice-epoch to make much progress in breaking up the continuity of the loess-steppes and to widen the distance between habitable areas.

The reaction did not begin until the inflow of water became insufficient to maintain the inland sea at its maximum of expansion. After this came the change to segregation of communities, first into larger groups of loosely connected units, then the breaking up of these into smaller groups.

Within the wider limits of the region more or less intercourse could exist between the delta oases on some stretches along the piedmont belt, and often still more easily between those on opposite sides of relatively low mountain ranges. The essential condition was a sufficient frequency of springs or streams to permit travel on foot.

Under such conditions, continued through thousands of years, the related peoples becoming isolated, in oases and oasis groups, would differentiate, each evolving its own culture along lines influenced by inherited traditions, environment, and racial character.

The development would in general, on account of the isolation, be peaceful, and, while alone and uninterrupted, would lack the benefit of acquisition of the new factors that come with intercourse with unrelated peoples.

The growth of population on these restricted areas was necessarily accompanied by evolution in social organization. We find the people living in towns, and the long continuance of life under individual town government, practically without external relations, while developing great individuality, must have given the many peoples thus situated certain fundamental political characteristics common to all.

In the same way, in so far as the physical environment was similar, certain classes of customs, arts, and occupations must have evolved along similar lines.

In so far as the peoples of larger or minor groups of oases differentiated from the same stock or from the same language stock, their languages would retain traces of the original generalized speech.

All these are ethnographic data to be carefully searched for in sifting and analyzing the results of future investigations.

It is certain that during this physiographic condition of the region in question, before the domestication of the horse and camel, there could be no movement of population, nor of organized bodies of men, nor of individual across the broader-limiting deserts or waterless steppes.

There are, however, several data among our finds from this earliest Anau culture which show that a certain amount of intercourse existed with other parts of the oasis-world. Turquoise beads, which occur as burial gifts with the skeleton of a child, must have come from Persia,

where it is known both to the south of Anau and farther eastward on the plateau.

Again, the importation I have mentioned, of an already domesticated pig and goat, of which the wild forms exist in India and Persia, indicates a relation with at least eastern Persia or Afghanistan; and the possession of domesticated animals on other oases shows that the peoples of other parts of our oasis-world had passed the line that is held by many to mark the transition from barbarism to civilization.

It is hardly conceivable that, if the peoples of these distant oases had known the art of making, from stone, axes and points for arrows and spears, this knowledge would not have been imported with the turquoise, the pig, and the goat into Anau.

We have at present no means of knowing how the earliest culture of our settlements at Anau stands in relation to the generalized cultures of central Asia before the segregation into isolated communities, for there have been made no other systematic excavations anywhere to discover traces of the older civilizations.

The constituents of the earliest culture found at Anau presuppose an evolution during many thousand years. How slow it must have been is shown by the almost unvarying character of its pottery during the two millenniums of its existence at the north kurgan.

When we compare this culture with the two succeeding and intruding ones, we find both differences and points in common. Each has its own peculiar technique in pottery and scheme of design in painted decoration. All three have in common a rectangular construction of houses of air-dried bricks, with doors swinging on pivot-stones; the same spindle whorls, the same bottomless bake-oven pots, the same mealing stones; and through it all there persists the same custom of burying children under the house floor in a contracted position. The differences are due to independent culture evolution in separate oases of one or of several groups. But the points in common date from an earlier stage in the forming of groups and presuppose beyond doubt a long period of dwelling in houses and of knowledge of the potter's art and of spinning, and, if we may judge from the mealing stones, possibly some form, however primitive, of agriculture.

Of these the peculiar burial custom and the mealing stone probably date from a still earlier and regionally more generalized culture. Perhaps we may say the same of the bottomless bake-oven, for it exists in use today far and wide over Transcaspia and northern and eastern Persia. The earliest acquisitions are often the last to be lost.

We are thus carried back two stages in the progress of differentiation of oasis groupings beyond the founding of our earliest culture at Anau; and I think most modern ethnologists will agree that this means periods of thousands of years. But, however far back this may go, the time interval must have been many times greater that elapsed between the culture that built houses, had the art of spinning and a developed technique in pottery and design, and that remote and generalized stage of paleolithic humanity in which the stone arrow-point and axe were unknown.

All this points to a regionally widespread autochthonous culture evolution, which owed its generic character to its early regional isolation and its differentiations to the segregation into oasis groups imposed upon it by the regional progress of desiccation.

In this respect it is a unique ethnographic province and stands in strong contrast on the one hand with the West, where early man could move throughout Europe, Africa, and Asia Minor, and with northern Asia and the Americas.

Origin of Agriculture and of organized settled Society

With the gradual shrinking in dimensions of habitable areas and the disappearance of herds of wild animals, man, concentrating on the oases and forced to conquer new means of support, began to utilize the native plants, and from among these he learned to use the seeds of different grasses growing in the dry land and in the marshes at the mouths of larger streams on the desert.

With the increase of population and its necessities, he learned to plant the seeds, thus making, by conscious or unconscious selection, the first step in the evolution of the whole series of cereals.

For a long time the rainfall was doubtless sufficient to ripen grains, as it still is in some of the valleys of Ferghana, and in some years even at Samarkand.

Later, experience taught the need, and some simple method, of artificial watering, and in this acquisition lay the germ of agriculture and of the conquest of the arid regions of the globe.

In Asia it rendered possible the civilizations of Elam and Mesopotamia. All the really great prehistoric cultures were developed in arid regions—all of those of which we have knowledge, and perhaps others of which we have not yet found the remains, in Mongolia, Arabia, and the Sahara, while in America we have an instance in Peru. The

fertile loess on the semiarid borders of such regions and the equally generous soil of the delta oasis were the foundation on which the independent cultures of village communities were built up. Only later, when the knowledge thus obtained could be applied to the utilization of great rivers in turning wide deserts into gardens, was it possible to render populous great countries under the centralized power that constituted empire.

This stage was never fully reached in central Asia and northern Persia. The countless isolated oases, even under Chaldean, Persian, and Arab dominion, never advanced really much more than nominally beyond the feudal stage.

If the hypothesis outlined in the last pages be well founded in its essentials, it follows that where we find among the acquisitions of the earliest of the cultures at Anau resemblance to those of neolithic cultures in the West, such similarity can not be due to importation from the Western spheres. If they are not due to coincidence, these acquisitions must be considered as having originated in our oasis world, and to have been transported beyond its limits after the domestication of the horse, or of the horse and camel, rendered extended intercourse possible.

Among such acquisitions we must include a knowledge of copper and lead and I think also the art of spinning.

We have seen the birth of the great inner-continental region of the Eurasian continent. We have seen that from the very conditions of its birth it was predestined to a definite course of life history peculiar to its kind, and, treating it as an organic whole, we have seen this course toward ultimate desolation temporarily modified by the climate of the Glacial period.

What I wish particularly to emphasize is the conception that, in the intervention of the Glacial period and its reaction on the inner-continental conditions, we must see the initial—the motiving—factors in the evolution of the intellectual and social life of man.

Shut off from the periphery of Asia and from the other continents while still in a low stage of savagery, we see him gradually broken up into smaller groups, which are forced into isolation on, in the main, continually diminishing, habitable oases; and we see on these the growth of differentiated, but fundamentally related, cultures. Lastly, and most important of all to us, we see here man under the spur of Necessity, the relentless goddess of evolution, building in village communities, in

agriculture, and in the essential industries the foundation of civilizations, to the reaction of which upon cultures evolved in the oases of the Sahara, and on the Nile, and in Mesopotamia we owe the framework of modern Western civilization.

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