with Observations on the Dinosauria of the Trias,"¹ remarks on the Dinosauria of the Urals. He suspects *Deuterosaurus* will prove to be a Dinosaur. This, however, falls within Owen's Theriodontia, as does *Rhopalodon*.

I venture to throw out the suggestion that the tooth now described indicates a reptile of the order *Dinosauria*.

All true reptilian (*i.e.* distinct from amphibian) remains from this formation in Russia which I have seen or heard of are theriodontine. Dinosaurian remains are as yet unknown. The miner is the sole agent we can rely upon for disentombing these Permian reliquiae. The absence of natural sections in the vast grass-covered steppes, and the reputation which the rocks of this age bear for paucity of organic remains, as well as the knowledge that the few which are derived from them are of a connective character, linking together the Palæozoic and Mesozoic epochs, invest every additional, though isolated, discovery with unique interest.

EXPLANATION OF PLATE VIII.

FIG. 1a. Canine of an unknown Theriodont reptile from Levsky mine, Kargalinsk steppe. 1b. 1c. 1d. transverse sections, 1e. crenation of border magnified. I am indebted to Mr. Thos. Rickard for the loan of this tooth.

FIG. 2. Incisor of *Deuterosaurus biarmicus* (Eichwald), from Roshdestvensky mine, Kargalinsk steppe.

FIG. 3. Supposed Dinosaurian tooth from the same locality.

The subjects of Figs. 2 and 3 were generously presented to me by Mr. Mr. Robert Fletcher of Lothbury. All the figures are natural size.

II.—ON THE ORIGIN OF THE LOESS.

By SEARLES V. WOOD, F.G.S.

VARIOUS theories have been advanced to explain the origin of the Loëss of Europe, Asia, and North America, the latest having been that of Mr. Howorth, in the pages of this MAGAZINE.

Although possessing no knowledge of this formation, outside of England, beyond that derived from the descriptions of those personally acquainted with it, I have for some time thought that the Loëss has originated from an agency of which I detect evidences among those phenomena of the Newer Pliocene period in England which I have endeavoured to trace in detail in a memoir on that subject laid before the Geological Society of London; but as the Loëss in general is not discussed by me in that memoir, I venture to offer a few observations on the subject of it for the consideration of her readers of the GEOLOGICAL MAGAZINE.

It appears to me that in all arctic countries not occupied with and ice, and where therefore the soil is permanently frozen to a great depth, and only the surface for a depth of two or three feet annually thaws, conditions must obtain, of which in temperate latitudes, save so far as the sliding away of an Irish bog may offer a partial parallel, nothing furnishes any analogy.

Although trees and vegetation grow freely during the summer on its small thickness of thawed surface, it is obvious that no water

¹ Quart. Journ. Geol. Soc. 1870, p. 72.

can penetrate the permanently frozen part below, and that the water arising from the dissolution of the snow, and from the summer rain which penetrates this thawed portion, must convert it into sludge; and that having no vertical downward escape, such as that which in climates where the soil is not permanently frozen supplies water to springs, and wells, all escape of the water thus saturating the thawed surface, which evaporation does not account for, must be lateral.

Where the material acted on is porous sand or gravel, this lateral escape may take place without any displacement of the material itself; but in imperfectly permeable material such as clay, and especially in such perfectly but slowly permeable material as limestone, the latter of which this perennial alternation of frost and thaw must rupture and convert into loam or marl, this escape cannot, I imagine, occur until the material has become so saturated as to be mobile.¹ In that condition its tendency must be to slide from higher to lower positions; and thus, while accumulating in the lower, to uncover and expose in a corresponding degree in the higher positions, more and more of what would otherwise be the permanently frozen portion to this action of alternate thaw and frost.

To this action during the minor glaciation I have, in the concluding part of the memoir referred to, attributed the origin of the "*Warp*" of Trimmer, the "*Trail*" of Fisher, and the "*Landwash or formation of great submergence*" of Prestwich, as well as that amorphous Cave-earth which has in so many cases evidently found its way into the caves through fissures in the rock from the surface above; while to the same but more prolonged action during the major glaciation, I have referred the clay with flints, which covers those parts of the chalk of England which were above the line to which the great submergence that was coincident with such glaciation in this country reached, and were not occupied by the land-ice. Up to that line the waves as the land gradually sunk removed whatever of this formation had previously accumulated, and as the glaciation endured for only the earlier portion of the emergence, whatever formed during that emergence below this line was small in quantity, and insufficient to give rise to such a distinguishable and uniformly distributed material as occurs above it, and which is susceptible of delineation on map.² Similarly this action during the minor glaciation has not been sufficiently prolonged to cover the surface in general with any considerable thickness of this material, or else, as England was during that glaciation nearly all in the condition of land, that part of the country of which the surface consisted of material favourable to the action in question would be enveloped by this material, instead of its being for the most part confined

¹ I propose in a subsequent communication to offer some remarks as to the peculiar material which has resulted from this action upon the chalk with flints, and which is not marl.

² It has in fact been mapped by the Geological Survey in parts of Herts and Bucks; and though I am not aware that the Herts portion is published, I have been kindly allowed to examine the MS. sheet containing it.

in any recognizable quantity to certain spots, such as the hollows presented by the buried cliffs of the south coast, and only thinly, and intermittently distributed elsewhere.

In England, where this formation has resulted mainly from the agency in question during the long duration of the major glaciation, and so covers the chalk which formed islands above the line of maximum submergence, it begins at the point where the Chalky-clay ceases, the land-ice of which that clay is the moraine having either (as is the case with the Chalk-wold of Yorkshire and Lincolnshire,) enveloped the chalk throughout the major glaciation, or (as is the case with the highest chalk summits near Royston and Baldock,) advanced over it during the emergence, and so ground off this material and covered the chalk with that moraine in lieu.

Now the Loëss of Continental countries appears to me to have originated in this way, and for the most part to belong to that portion of the formation which accumulated during the prolonged rigour of the major glaciation.

So much of it as is represented by the "Limon Hesbayen," which wraps all Southern Belgium as well as a part of Northern France, sets in at the line where the Campinian sand ceases, and covers what I consider to have been land during the Glacial period or during part of it. This sand, on the contrary, I have in the first part of the memoir already mentioned (Quart. Journ. of the Geol. Soc. for 1880, page 477) referred to the sea which by the great westerly and southerly depression of England during the major glaciation extended over this country generally, from the eastern side of it, to which during the Crag it had been confined, so as to engulf England to a depth which increased westwards to near 1400 feet in North Wales, and southwards to near 700 feet in Hampshire. The part of least depression, and where probably this did not reach 300 feet, was North-east Suffolk and East Norfolk; and as this depression diminished still more towards Belgium, the sea shoaled more and more in that direction, until the shore of it is marked by the line where the Campinian sand terminates, and the Limon Hesbayen sets in. The region occupied by this sand appears to me to represent a flat and shallow part of the bottom of this sea, being that which extended along the shore of the land at the time which is represented by the Limon Hesbayen. This flat bottom as it became land during the slow recession of the sea, while the more deeply engulfed region of England was emerging, also became covered with an Eolian formation of Dunes raised by the wind as the sea receded from the sand of the shore-line as this gradually advanced from the recession of the sea; for the Campinian sand appears to lose its Eolian character downwards, and to pass at bottom into gravel and shingle.¹ The limit of the Limon Hesbayen in France similarly, I think, marks the continuation of this shore line; for though the evidences of this submergence have mostly been removed in Northern France, it is hardly conceivable that the sub-

¹ Van den Broek, and Cogels, *Ann. Soc. Malacologique de Belge*, vol. xii. and xiv.

mergence, which reached the elevation at which it is traceable in the South of England, should not have extended some way over the North-west of France; and indeed gravels occur there which appear referable to this, though, as is the case with the South of England, the action of the waves during emergence have removed all but a few patches of such gravel which now remain to show its original outspread on this sea-bottom.

Over the portion of France, therefore, where this submergence extended, the area beneath the line of it would be destitute of this atmospheric formation of the major glaciation, in the same way that the corresponding part of England is; but the similar formation resulting from the agency in question during the minor glaciation would occur there; and this I take to be the limon, or brick-earth, which covers the lower chalk plateaux of Picardy, and which wrapping over the Picardy valley slopes is the same, M. de Mercey says,¹ as covers the *Cyrena* gravel of the Somme Valley, and buries the old Picardy shore-line, that is to say, the shingle and cliff of Sangatte, near Calais, thus corresponding with the material under which the ancient cliffs of Brighton, Isle of Wight, Foreland, Portland, and Sili Bay in Glamorganshire are buried, which, like the Picardy limon, is full of angular fragments of flint in the chalk districts, and of other stone elsewhere, due to the shattering effect of intense frost acting on the moisture which penetrates even solid flint.

The Loëss seems to occur throughout all that part of the Northern hemisphere which falls within those latitudes which must have had an Arctic climate during the Glacial period, and through that part only; the molluscan remains which it has yielded being those of land-shells alone. The land-ice from the moraine of which most of the Glacial clays have originated, and which *protected the land surface from the agency in question*, was confined to those regions, such as Scandinavia, Ireland, Scotland, and the Northern part of England, where, though the mountains were of small altitude, they were close to the source of the snow—the Sea, or to those more inland regions where the greater mass and elevation of the mountains caused the fall of greater volumes of snow than the summer sun could remove, and which therefore invaded and overwhelmed the low grounds. Beyond these regions, and embracing by far the larger part of the Europeo-Asiatic continent, were those where the snowfall was less than the summer sun could remove, and consequently no land ice; and here, under the intense Siberian-like climate of the time, the action in question went on. In North America the Loëss extends apparently over the region drained by the Mississippi and its numerous tributaries, and sets in where the evidences of the land ice, which seems to have filled the whole of St. Lawrence and

¹ Bulletin de la Société Linnéenne du Nord de la France, p. 303. As M. de Mercey describes this limon as reaching from nearly the bottoms of the valleys in Picardy to elevations of more than 200 mètres, and on the plateaux as attaining a thickness of 30 mètres, I infer that part of it, like the clay with flints in England, originated chiefly during the major glaciation on that part of the chalk with flints which was above the line of submergence during some part at least of the period of this glaciation.

Lake basin, and covered the Adirondack Mountains, terminate. This Loëss in the Mississippi valley teems (according to Sir C. Lyell, in *Antiquity of Man*, p. 237) with land-shells, and occasionally graduates near the rivers into a subjacent and more stratified deposit containing freshwater shells.

I have made these observations as brief as possible, both because my knowledge of the Loëss is limited in the way already mentioned, and because I desire to offer them as tentative only; but I incline very strongly to the belief, now less in fashion than it was, that the explanation of Geological phenomena is to be sought in causes still existing, rather than by resort either to causes wholly supposititious, or only now found to be in action to some very subordinate extent.

III.—THE LOESS—A REJOINDER.

By HENRY H. HOWORTH, F.S.A.

WHATEVER the result of this controversy, your readers will not be ungrateful to me for having been the means of drawing from such a distinguished explorer and geologist as Baron von Richthofen, the vigorous defence of his views which appears in the last Number of the *GEOLOGICAL MAGAZINE*. The admirable work he has done in China it would be an impertinence in me to praise; but I may be allowed to say that a large part of it will outlive any ephemeral discussions about the Loess—discussions in which there must be a considerable element of doubt, whatever theory is adopted. I cordially thank Baron von Richthofen for the kindly terms in which he refers to my writings on the history of the Mongols. Having done so, I would express a feeling, shared perhaps by others than myself, that, when discussing my views about the Loess, which were, I hope, stated in deferential language, it was hardly necessary to adopt expressions which are not quite judicial. The polemical vocabulary of Germany is proverbially somewhat tropical, and seems to some of us to be more adapted to religious and political strife, where feeling plays a large part, than to the dissection of cold scientific facts, where neither authority nor vigorous assertion avails much. Especially is this so in addressing a cultivated audience like that which your pages are likely to reach. If Baron von Richthofen's theory had been generally accepted in the scientific world, a little emphatic dogmatism might be overlooked; but as this is the very opposite of the fact, and the only difference between us is, that while he is a distinguished heretic, I am an obscure one, it seems to follow that the most seemly language for each party to use, especially for the one who has every claim to a wide reputation, is that of sobriety, if not of hesitation.

Turning from the manner to the matter of Baron Richthofen's paper, I confess to being greatly surprised. It is quite true that his work upon China is incomparable in its way, and will become a classic; but he is not the only writer who has dealt with the Chinese Loess after a long and familiar acquaintance with it. Father David, whose admirable papers in the *Nouvelles Archives du Museum*