THE FACE OF THE EARTH

(DAS ANTLITZ DER ERDE)

BY

EDUARD SUESS

TRANSLATED BY

HERTHA B. C. SOLLAS

UNDER THE DIRECTION OF

W. J. SOLLAS

VOL. V

INDEXES AND MAPS

OXFORD
AT THE CLARENDON PRESS
1924

Oxford University Press
London Edinburgh Glasgow Copenhagen
New York Toronto Melbourne Cape Town
Bombay Calcutta Madras Shanghai
Humphrey Milford Publisher to the UNIVERSITY

Printed in England

PREFACE

FIFTEEN years have elapsed since the appearance of the text of this translation. Many causes, all unavoidable, have contributed to this deplorable delay; chief among them the Great War. An index, prepared from a translation of the German, was on the eve of publication when the war broke out; on revision, however, the original was found to be so inadequate that a fresh index had to be compiled from the pages of the English text.

Difficulties arising over the publication of the maps which accompanied the last volume of the German work, while increasing the causes of delay, had at least one fortunate result for they led Prof. Suess to enrich the present volume with some diagrams from his own pen. These will be found of great assistance towards a clear understanding of much descriptive matter in the text: those on Plate 1 will enable the reader to comprehend at a glance some of the novel conceptions with which the author has illuminated the study of orography; that on Plate 3 is a sketch-map representing on a larger scale the eastern part of Map III.

W. J. SOLLAS.

REMARKS ON THE MAPS

MAP I: ANALYSIS OF THE EARTH'S SURFACE

(see vol. iv, p. 498)

ALTHOUGH our knowledge of the structure of the earth's surface is still extremely fragmentary, yet it is possible to recognize some of its most important features. In the Atlantic hemisphere two regions in particular may be distinguished, characterized by their greater age; *Laurentia* and *Gondwána land* (both coloured *red*). The first of these comprises a large part of North America, Greenland, and possibly the western Hebrides, along with some of the western promontories of Scotland. To the second belong the eastern part of South America from the Orinoco to Cape Corrientes, Africa almost in its entirety, Madagascar, and India. Both regions are forelands throughout their whole extent, and thus older than the folded ranges thrust against them; both are entirely devoid of recent folding with the exception of their western margins, where, in Canada and Argentina, the folding of the Rocky mountains and the Andes involves, for a certain distance, the stratified series of the foreland. This series is characterized by its lacunae, notably from the Carboniferous to the middle Cretaceous. Where Cambrian beds occur they lie horizontal. The Falkland islands have been assigned to Gondwána land; it would perhaps be more correct to include them in an *Antarctis*. For it is not improbable that another similar region may one day be shown to exist in the south.

All the regions mentioned above are broken up by Atlantic subsidences. Without any visible connexion the pre-Cambrian Bohemian mass makes its appearance in the middle of Europe. It is an independent horst. To the east of the last traces of Laurentia the *Caledonides* (*brown*) crop out. The first indications of these mountains are to be seen perhaps in north Spitzbergen. They form the western half of Scandinavia, the Orkney and Shetland islands, and the greater part of Great Britain. Their direction is submeridional. The Devonian lies flat and unconformable upon their folds. They separate the Hebridean gneiss from the Baltic shield. In Scandinavia they are overfolded towards the east, in Scotland towards the west.

The *Saharides* (*brown*) which strike through the midst of the Sahara to Dahomey correspond, so far as they are known, both in position and direction to the Caledonides, yet in these mountains the unconformable transgression begins as early as the upper Silurian graptolite shales. Since there is some doubt as to whether the upper Silurian of Scotland still shares in the folding beneath the Devonian covering, it is not impossible that the Saharides may one day prove to be the continuation of the Caledonides. Then it will be advisable to distinguish an eastern and a western half in Gondwána land.

The *Asiatic system* (*green*) includes in East Siberia, *Angara land*, which has many characters in common with the ancient forelands of Laurentia and Gondwána. The Cambrian beds, for instance, lie flat and there is no recent folding. Angara land, however, must on the whole be regarded not as a foreland but as a backland, although the surrounding chains not seldom exhibit backfolding. Nor is it broken up like the above-mentioned forelands. Its limits are sharply marked in the direction of the Primorskii range (west border of lake Baikal) and to the south of Irkutsk, but towards the north its plateaux in East Siberia dip beneath the Mesozoic transgressions, and to the west of the Yenisei the covering of recent detritus, which extends as far as the Urals, does not permit us to determine them with certainty.

The inner part of the Asiatic structure is surrounded by a wide girdle of arcuate folded ranges, convex towards the exterior. They make their appearance in Ellesmere Land, form the East Asiatic island festoons (Ochotides to the Philippines) and the southern marginal arcs (Burman arc to the Mediterranean), and are represented in a somewhat different manner in the Uralides. Outside the latter lie the Russian platform and the Baltic shield; here, too, as in the interior of the structure, the Cambrian beds lie flat.

The folded arcs proceed from vertices; a very ancient vertex surrounds Irkutsk (Baikal vertex), another forms the mountains of Minuzinsk and is of pre-Devonian age; a third forms the Altai mountains; it originated within the Carboniferous period. Many additional secondary vertices complete the great structure, and their folds are frequently resolved into virgations, opening chiefly to the west or south-west, as though they were influenced by rotation of the planet or bodily tides. But this does not hold good for the Burman arc.

The structure is not continuous. The first interruption is to be seen in Alaska, which is built entirely on the plan of the East Asiatic arcs, while its outer folded range, the Chugatsk mountains, enters into normal syntaxis with the St. Elias range, and its inner range, the backfolded (folded towards the north) Romanzov (Rumanzof) range enters with equal regularity into syntaxis with the Rocky mountains. The Rocky mountains—which in their northern

part are folded towards the east, are then stowed against the Colorado plateau and break up into coulisses—must be regarded as a free branch of the Asiatic system, which, relatively to Asia, like the Romanzov range, is back-folded.

The second interruption is caused by the far-reaching Burman branch. It proceeds from the vertex of the Altai and belongs to the range of the eastern Altaides.

The third interruption is due to the western Altaides. These mountains advance south of the horst of Azov, to Europe, form the middle and south of this continent, and reach the Atlantic coast, where they are very broad, between the south-west of Ireland and the Wady Draa. In this case, as in the Burman arc, the outer range exceeds all the others in length and then terminates in a free end. It dips beneath the sea in the rias coasts of Ireland and Brittany, reappears in the rias coasts of Newfoundland, forms the Appalachians, and reaches with its outermost spurs, on the other side of the Mississippi, even the outer border of the western Cordillera. In this way all the southern part of Laurentia is surrounded, as a foreland, by the outrunners of the Asiatic system.

From the horst of Azov onwards, the folding turns to the north; thus, just as in the case of the Rocky mountains, all this part of the western Altaides is backfolded in relation to Asia.

The folding of the Rocky mountains came to an end at the close of the Cretaceous epoch; from Alaska and all around as far as the Mediterranean the folding continued into the Tertiary era or even later. In Europe different conditions prevailed. The folding of the Appalachians was concluded before the Permian epoch. In the northern Urals also only older movements seem to have occurred, but the very recent Yergeni mountains in the south must be regarded as outrunners of the Uralides.

The long folded ranges of the Asiatic system include older masses which are probably comparable in many respects to Angara land; this is especially the case in China, Siam, Cambodia, and southern Borneo.

From Guam onwards the south-eastern part of the Asiatic arcs is separated from the arcs of the Oceanides by considerable foredeeps, but an ancient fragment appears to be visible on this boundary in the peninsula of *Beru* (New Guinea) and a branch of the Sunda islands (*yellow*).

The *Oceanides* (*violet*) include important islands, like New Guinea, which are unexplored, but we know that the main ranges are true folded mountains. A great virgation seems to proceed from northern New Zealand. The wide arcs include Australia, which probably adjoins Antarctis, and thus occupies a position, as a backland within the arcs, similar to that of Angara land within the Asiatic arcs. A study of Timor would be likely to throw fresh light on this point. *Viti Levu* (*yellow*), and possibly Yap also, are probably small parts of older masses situated between the folds.

The *Cape Mountains* (*yellow*) are the remains of a great mountain system, with a structure similar to that of the marginal arcs of Asia. They consist of three parts, the Cedar mountains in the west, the Zwarte mountains in the south, and the Pondo mountains, known only in a few fragments, in the east. They are arranged in precisely the same manner as the great mountain chains of India; the Karoo is the foreland against which they are stowed. The folding, however, is directed to the north and not as in Asia to the south. On the west the Zwarte mountains unite with the Cedar mountains, in regular syntaxis, while their eastern end, next the Pondo mountains, lies beneath the sea.

The structure of this mountain fragment turned towards the north, and forming a counter-part to the marginal arcs of Asia, may be cited, along with the prevailing direction of the virgations, to prove the influence of the rotation of the Earth or of tides on the development of the general plan.

The *Intermediate Range* and the *Andine system* (*blue*) form that part of the face of the Earth which, as compared with the rest of the plan, is most difficult to interpret. Even within the arc of the Aleutian islands, and extending right up into Cook Sound, an arcuate, trough-shaped subsidence occurs, which is characterized by Mesozoic sediments and active volcanos. The same features present themselves in the volcanic group of the Wrangell islands, on the other side of the syntaxis, and are continued in the direction of the Lynn Canal, and the great batholite of Columbia, of which the recent volcanos of the Cascade mountains are regarded as a further prolongation. In the Basin mountains the same structure is repeated. The ancient rocks of the Californian coast ranges may be regarded as the beginning of the Andine system. Their trend-lines strike through Lower California and the Mexican Sierra del Sur to Guatemala, then bend outwards towards Cuba and Jamaica, return through Trinidad and Venezuela, and finally reach in Ecuador the South American part of the Andine system. Here two elements may be distinguished, namely the Cordillera Real, a range folded towards the east, in which the folding, as mentioned above, involves part of the foreland; and the Cordillera de los Andes, in which over large areas the features of the Intermediate Range reappear, that is, long trough faults, marine Mesozoic deposits, and active volcanos. In Patagonia the trend-lines again turn outwards to the Atlantic Ocean, then bend back in an arc, accompanied by the volcanos of the South Sandwich islands which represent those of the Lesser Antilles, and finally reach Graham's Land, the northern part of which takes the place of Venezuela. Thus we may speak of a Northern Antilles and a Southern Antilles.

Both groups of Antilles indicate, like the Cordillera Real, a folding towards the east. The trough-like subsidences of the Cordillera de los Andes add no light on this point. It is, however, very significant that in

Asia and the Northern Antilles the foredeep always lies in front of the folded chains and that on the west side of South America there is a long foredeep, although no range folded towards the west has so far been discovered. Possibly a closer investigation of the most westerly parts of the Andes may throw some light on this point.

The *active volcanos* are not marked on the map; to indicate their relation to the structure it would be necessary to represent at least the most recent extinct volcanos, as well as the recent batholites. However, the following general laws may be recognized: Where recent folding occurs, the active volcanos follow the trend-lines, notably in the peripheral arcs of Asia. In the forelands, however, they are almost entirely absent, with the exception of those parts which are sunk beneath the sea. Africa forms an exception, but there the volcanos follow straight lines, which are independent of all folding. The active volcanos of the Atlantic subsidences are generally arranged in groups, and the same rule holds for that part of the Pacific Ocean (*hatched*), which lies west of South America. The volcanos of the Lesser Antilles, and probably those of the South Shetland Islands, resemble those of the Asiatic arcs. The trough-shaped subsidence of the Eastern Aleutian and Wrangell islands differs from the African troughs in so far as the two sides do not belong to the same, but to different mountain ranges; on the other hand, in the Basin ranges and probably also in the Cordillera de los Andes typical trough subsidences occur. Whether the Antarctic Erebus chains may be classed with the African volcanos is a matter for conjecture.

MAP II: ANALYSIS OF EUROPE

All those regions which are older than the Devonian have been left blank. These include: those parts of north-west Scotland which possibly belong to Laurentia, then the Caledonides, the Bohemian mass, and that part of the Asiatic structure which was not subjected to later foldings, in particular the Baltic shield and the Russian platform. In the south of the map the Sahara is left blank for the same reason, and also the African coast to the east of the Syrtes, Egypt, and Syria.

The folded ranges which belong to the periphery of Asia are coloured *green*. Of these, one part appears in the north, and another in the south of the map. In the north are the *Uralides*. It is true that they do not lie on the periphery, but the way in which the folds extend beneath the sediments in the east, and the disposition of those branches which extend as far as into the north of Scandinavia, show—in spite of stowing back in the middle of the principal branch (on the Ufa)—the intimate connexion of the Uralides with Asia, and their similarity in structure with the peripheral

arcs. The position of the Russian platform and the Baltic shield thus acquires a certain resemblance to that of the ancient fold-surrounded masses of south-east Asia.

In the south of the map, the normal *marginal arcs* of Asia are seen, namely, a part of the Iranian arc, entering into syntaxis, almost in the meridian of Diabekr, with the Tauric arc, which in western Asia Minor unites in its turn in close syntaxis with the Dinarides. These last insert themselves between the Alps and the Apennines and so surround the lakes of northern Italy.

The Yergeni Mountains of late Tertiary age are regarded in this work as recent spurs of the Uralides, while the main ranges are represented by the Mugodjars as far as the tableland of Ust-Urt, between the Caspian and the Aral. In the marginal arcs also, the folding was continued into the later stages of the Tertiary era.

Blue marks the *Western Altaides* which here break through the periphery of Asia. This interruption may be recognized by its Caucasian strike opposed both to that of the Uralides (*green*) and of the syntactic marginal arcs (*green*). The Western Altaides are the continuation of the virgation of the Thianshan; a small part of them arrive north of the horst of Azov, a far greater part south of it; both with a west-north-west direction.

A northern line runs from the peninsula of Mangishlak (north-east of the Caspian), and strikes across the upper course of the Manytsh into the coalfield on the Donetz (*blue*). It maintains the west-north-westerly direction, and a series of rectilinear disturbances, striking between north-west and west-north-west in Germany and as far as Scania, may possibly be regarded as a further radiation from it (Karpinsky's lines, Fichtelgelirge, Teutoburger Wald, and others; these are not marked on the map owing to its insufficient scale). These lines are of various ages; the south side is often faulted down and overthrust from the north.

The Caucasus, which runs parallel to these lines, sends its outrunners to the south of the horst of Azov. In the Caucasus, as in the southern marginal arcs and, it would seem, in the whole periphery of Asia (with the exception of Manchuria?) the recent folds accommodate themselves to the trend-lines of the ancient folds, so that uniform chains arise, even though, in the interior of these chains, and especially at the base of the Upper Carboniferous or Permian, violent unconformity may exist. This is also the case in the Dinarides; but the ranges of the Altaides, which reach the south of the horst, behave otherwise. The folding which in Asia is directed to the south, and in the Caucasus partly to the north and partly to the south, turns to the north, and at the same time the most recent folds are separated in space from those in which the folding was completed before the upper Carboniferous or Permian.

The *pre-Permian Altaides* (*blue*) are divided up into horsts by subsidences. They comprise: the Variscan arc (from the Sudetes to Valenciennes, and from the east side of the Central Plateau to the upper course of the Allier), the Armorican arc (west of the Central Plateau, Brittany, Devonshire, Cornwall, the southern border of Wales and Ireland), the Montagne Noire (connected on the south-west with the Central Plateau, together with the Cevennes, and on the other side with the mountains of Barcelona), the Cor-Sardinian arcs, the Spanish Meseta, the Great Atlas, and on the other side of an unknown region between Long. 4° and 5° E., the mountains of the Jebel Bechar near Figig. They also extend southwards into the Sahara,[1] and Gautier suspects the presence of another pre-Permian syntaxis in Gurara.[2]

These horsts surround the fields of subsidence within which the *Posthumous Altaides* have arisen. First of all a wedged-in fragment, the *Cimmerian range* is intercalated (*violet*; Crimea, Dobrudcha, small areas on the outer border of the Carpathians) the folding of which was completed before the Cretaceous epoch came to a close. Towards Theodosia some upper Tertiary folds, continuing the north-eastern border of the Caucasus, divide into two branches which embrace forkwise its eastern end.

Then follow (*red*) all those ranges, of which the folding, within the frame, persisted into the middle or close of the Tertiary era. These are: the Alpides (Balkans, Carpathians, Alps, Apennines, Mediterranean Atlas, Gibraltar, and the Betic Cordillera as far as Majorca), the Maures, the Provençal folds, and the Pyrenees, together with the Cantabrian mountains, and a number of fragments, the connexion of which has not yet been discovered (N.-W. and S.-W. Sardinia, Minorca, mountains on the lower Ebro; also the Montes Universales), further the recent folding within the London and Paris basin (e.g. the Pays de Bray and the Weald), and that within the basin of western Portugal (Sierra de Arrabida).

These posthumous folds often include parts of the older structure; pre-Permian fragments make their appearance in the Balkans, and above all in the zone of Mont Blanc; they play a large part in the structure of the Pyrenees; they are seen also in the Mediterranean Atlas and elsewhere. On the map only the mass of Monthoumet has been marked; this mass, surrounded by the Provençal folds, lies in front of the Pyrenees. On the north Cimmerian, i.e. pre-Cretaceous elements are also present, especially in the eastern Carpathians.

Some of the Tertiary and still later subsidences of the Mediterranean probably illustrate the processes which brought about the breaking up of

[1] H. Poirmeur, Bull. Soc. Geol. de France, ser. 4, vol. vi, 1906, pp. 724–8, pl. xxvi, Geol. map.

[2] E. F. Gautier, *ibid.*, p. 729, map, pl. xxvii; most clearly seen near Lat. 29° N., Long. 0° 10′ W.

the Altaides into horsts. These subsidences extend in the Aegean Sea over the marginal arcs, and in the eastern Mediterranean over the African platform. Nowhere, outside the Altaides, have posthumous structures arisen in them, but the African tableland appears to have been faulted down on the margin of the Mediterranean Atlas, and this is also the case with the Russian platform where it faces the Carpathians, and possibly also in the direction of the coalfield of the Donetz.[1]

The subsidences are marked by horizontal hatchings.

In the south-east the fault-trough of the Dead Sea is shown on the map; the fault-trough of the Rhine which cuts through the Altaides belongs to the same group of fractures.

MAP III: RECUMBENT SHEETS OF THE ALPS

In this diagrammatic representation many details are omitted (e. g. the intrusive zone on the border of the Dinarides), and it is only intended to serve as an introduction to the investigation which is attempted in vol. iv, chaps. iv, v, vi.

Thus simplified the chief range of the Alps appears to be formed of three sheets overthrust from the south: to these an alien element—the Dinarides—is added, which inserts itself between the Alps and Apennines, dips beneath the latter, and probably plays some part in determining the great bend of the Western Alps.

We begin with the *Helvetian sheet* (*blue*), from which, between the Isere and the Rhone, the *Jura mountains* branch off. This range is completely autochthonous; the folding decreases towards the exterior, except in those places where the mountains are stowed against the foreland, as at the eastern end of the Rhine Valley.

The piling up of Alpine sheets becomes somewhat more comprehensible on the hypothesis that an important foredeep, beginning between the Helvetian sheet and the Jura, lay in front of the existing Alps, and occupied also part of the site of the Helvetian sheet up to the east side of the Bohemian mass. Such foredeeps lie in front of the folded arcs of Asia and the Northern Antilles, and may attain a depth of 7, 8, or even 9 kilometers and more. Nevertheless, the Helvetian Alps must be described as autochthonous, for the distance over which they have been driven falls far short of that attained by the succeeding sheets. On the west the zone of Mont Blanc forms their inner concave side; from the Mercautour up to the mass of the Aar they include mountain cores of a similar structure to the Variscan

[1] V. Laskarev, Bull. Com. Géol. St. Petersburg, 1903, xxiv, p. 235, map.

foreland. The fossiliferous succession begins with freshwater, middle or upper Carboniferous deposits.

The zone of Mont Blanc ends west of the Rhine, and only the outer zones of the Helvetian Alps cross the river; further on only Cretaceous and Tertiary deposits, chiefly in the form of Flysch, represent the Helvetian Alps and continue beyond Vienna into the Carpathians.

The *Lepontine Sheet* (*red*) is bordered on the west by a band of Oligocene flysch. It advances from the sea into the interior of the Alps, and its up-folded or pinched-in remains may be traced from the east side of the Helvetian Alps up to Mont Blanc, as though at so late a period two independent mountain chains had approached each other. The whole of the Piedmontese Alps must be assigned to the Lepontine sheet; beginning in the south and striking across the Grand Paradiso, it occupies the whole space from the Helvetian Alps (Mont Blanc zone) to the plain of the Po, and from Ivrea and Biella to the boundary of the Dinarides and the upper Valtellina.

Separated from this main range translated fragments of Lepontine sheets lie on the Helvetian Alps. They begin between Mont Mercantour and Pelvoux, where the inner Flysch zone is deeply involved in the movement. They reappear south-east of Annecy, attain a much greater extension in the Chablais and the Freiburg Alps, and then proceed as a long chain of smaller fragments as far as the neighbourhood of Buchs in the valley of the Rhine. They consist as a rule of several series of Trias and Jurassic rocks piled up one over the other and drawn out; they do not present precisely the same facies, and some parts may even be derived from different zones of the Alps. But they all come from the south, and that a great part at least are derived from the remote Lepontine is shown not only by their divergent nature but also by the fact that in the east, just on the other side of the Rhine, the Lepontine sheets may be seen dipping beneath the Eastern Alps over such large areas that the covering up of the Helvetian Alps across their whole breadth is plainly indicated.

Lepontine beds may also be seen on the other side of the Rhine. Some traces occur near Hindelang in Bavaria on the boundary between the Helvetian and East Alpine sheets, but they are exposed in windows over much greater areas beneath the East Alpine sheet. One of these Lepontine windows opens along the Inn over a distance of 54 kilometers, between the Selvretta and the Oetz; another much larger still, 165 kilometers long, forms the Tauern; a smaller one occurs on the Semmering. In the Tauern and on the Semmering the stratified series visible through these windows begins, as in the Helvetian Alps, with freshwater, plant-bearing beds of middle or upper Carboniferous age. From the Semmering a band of these Carboniferous beds strikes to the south-west through the Mürzthal and then to the north-west towards Liezen (*red crosses*); its tectonic significance

is uncertain. In like manner, a band of marble of unknown but possibly Mesozoic age runs from the western end of the Tauern window towards the west, while a second runs towards the south-west and crosses the Etsch (*red rings*).

In the north-east may be seen extending from Gmunden to Vienna, close to the southern margin of the Flysch zone (the equivalent of the Helvetian Alps), the repeated local occurrence of a Mesozoic series, which has several characteristics in common with the fragments of the Lepontine sheet, but presents perhaps an even closer resemblance to the Pienines (*red rings*).

The western part of the boundary of the Dinarides is distinguished by a band of green intrusive rocks, the zone of Ivrea. Similar green rocks attain a very wide distribution and not only in the Piedmontese Alps from the south to beyond Monte della Disgrazia, but also in the fragments of the overthrust sheet and in the window of the Inn ; they are also represented in the Tauern. Though opinions may differ as to their nature these rocks remain none the less a proof of the common origin of all these fragments of the Lepontine sheet.

The *Dent Blanche* (*hatched*) is a sheet by itself which appears to be derived directly from the immediate neighbourhood of the Dinaric boundary. Here Lepontine rocks overlie Lepontine rocks.

The *East Alpine sheet* (*brown*) extends from the Rhaeticon to the Hungarian plain. In the north it consists of a broad zone of Mesozoic limestone, which lies in long folds, passes towards the east into sheets and flakes thrust towards the north. In contrast to other parts of the Alps there lies beneath it, from Tyrol to the East, and especially in Styria, a series of marine Silurian, Devonian, and lower Carboniferous beds. Fresh-water Carboniferous is unknown. Below the Palaeozoic series lie the pre-Cambrian rocks, distributed over a wide area. Directly upon these rests the western part of the Limestone Alps, then the Ortler group and the Mesozoic series of the Drave valley, and the Gurka valley in Carinthia, which all repeat the facies of the Limestone Alps. In the valley of the Drave, long longitudinal faults make their appearance; in the east some members of the Silurian and a well-developed Devonian extend as far as Gratz. The boundary of the Hungarian plain is formed by some caldron subsidences and is accompanied by a zone of Tertiary trachytes and basalts.

The East Alpine sheet is thus thrust towards the north over Helvetian rocks and perforated in the middle by Lepontine windows; in the south the Dinarides crowd upon it, and we must assume that it dips beneath these mountains. Whereas in the west green intrusive rocks mark this boundary; further away tonalitic and granitic batholites are exposed over a distance of about 400 kilometers. They lie partly in the Alps, partly in the

Dinarides, or on the boundary of the two. In the extreme east Oligocene andesites also occur; that these belong genetically to the tonalites may be conjectured from analogies observed elsewhere.

The *Dinarides* (*green*) are foreign to the Alps. With great regularity their folds strike through Bosnia and the Dalmatian archipelago, bend round in Carinthia, out of the north-westerly direction to the west, present overthrusts towards the interior in the region of the bend, extend as far as Meran, and sink along the southern border beneath the plain of the Po. The bay between Padua, Schio, Görz, and Pola is an independent field of subsidence.

The Dinarides are thus a part of the normal marginal arcs which form the southern periphery of the Asiatic system, whereas the Alps belong as posthumous structures to the Altaides which break through this periphery. Apart from their position the Dinarides display two characteristics which are typical of Asia; they are not folded to the north like the Alps, but to the south, and although they present a marked unconformity at the base of the upper Carboniferous, the more recent folds are not separated spatially as in the posthumous Altaides.

The underlying beds are visible in the *Carnic Alps* (*violet*) as a long band following the boundary. It consists of Silurian, Devonian, and marine lower Carboniferous beds and appears in contrast to the chief mass of the Dinarides to be folded towards the north. But too much importance should not be attached to this circumstance, since on the boundary stowing to the north prevails over a great distance. Here also the unconformable superposed series begins with upper Carboniferous plant-bearing beds with which, however, marine sediments are intercalated, a feature which occurs nowhere else in the Alps. In the Permian also marine sediments which are not known further north make their appearance, and the facies of the Mesozoic sediment likewise differs from that of the East Alpine beds which often are only separated from them by a valley. To the Permian belongs the porphyry mass of Botzen.

Where the Alps bend round to the Appenines a dip to the west occurs on the inner side, probably in consequence of local backfolding within the curve. Further south several small gneiss ridges detach themselves and advance as arcuate free ends along the rivers Maira, Veraita, and Po towards the plain; at Saluzzo the strike of one of these outrunners is actually north-north-east. This may be due to the dying out of the backfolding. The western part of the Alps continues the direction of Mont Mercantour, and to it belong the Ligurian Alps. Here the strike approaches more and more closely to the meridian. The Ligurian Alps may be regarded as a horst-like segment, bounded on the south by the Tyrrhenian subsidence, and on the north by the transversely striking Tertiary deposits of Turin, which represent a free end, turned backwards, of the outer border of the Appenines.

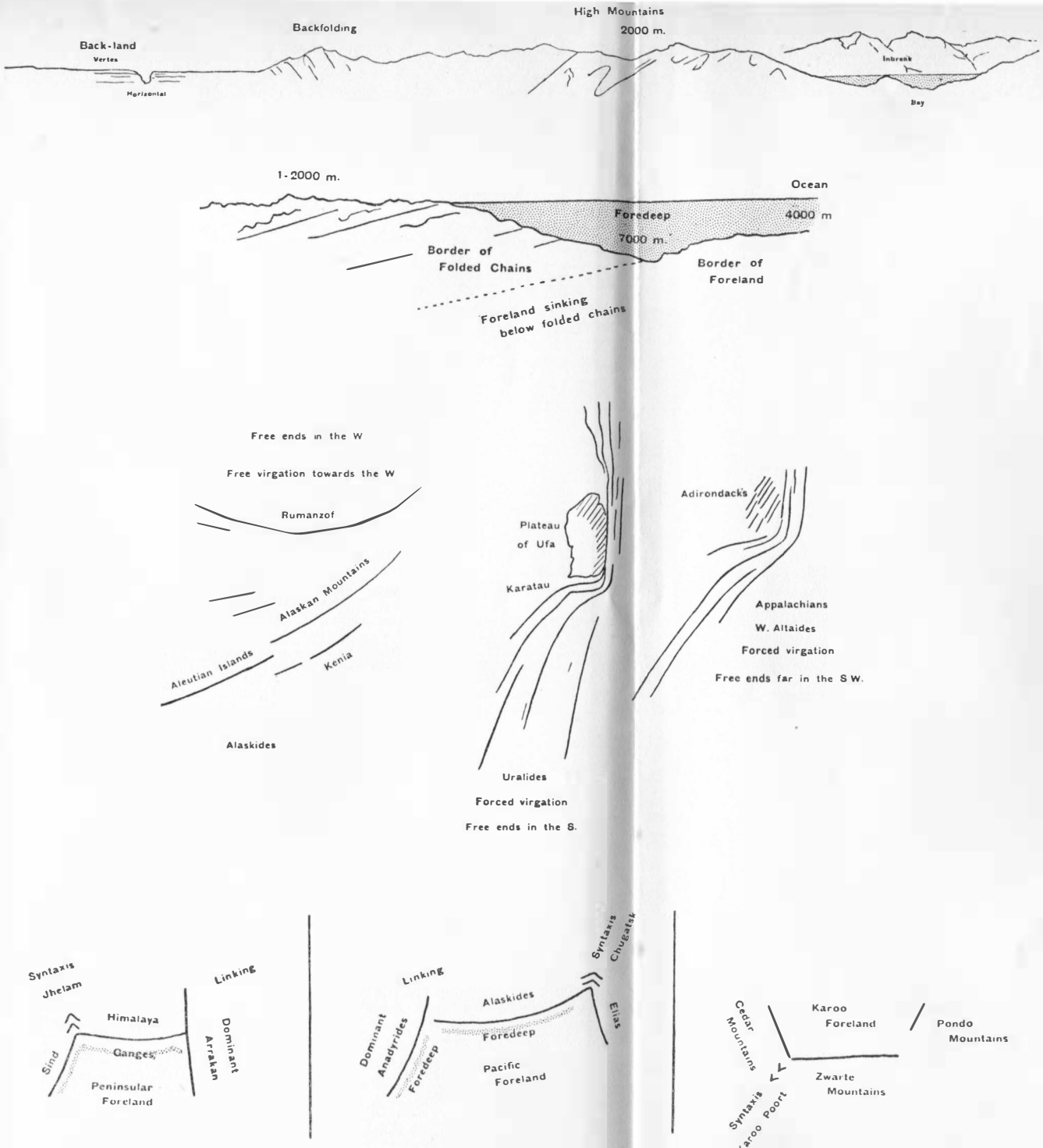
The further continuation of the Alps lies in north-eastern Corsica, the island of Elba, and, with a progressively divergent strike, in the Appenines.

The preceding data all refer to post-Cambrian movements only, but in the north of the United States, in Finland, Bohemia, and other regions independent pre-Cambrian movements have been recognized; no conclusion, however, can be reached at present as to their mutual relations and general disposition.

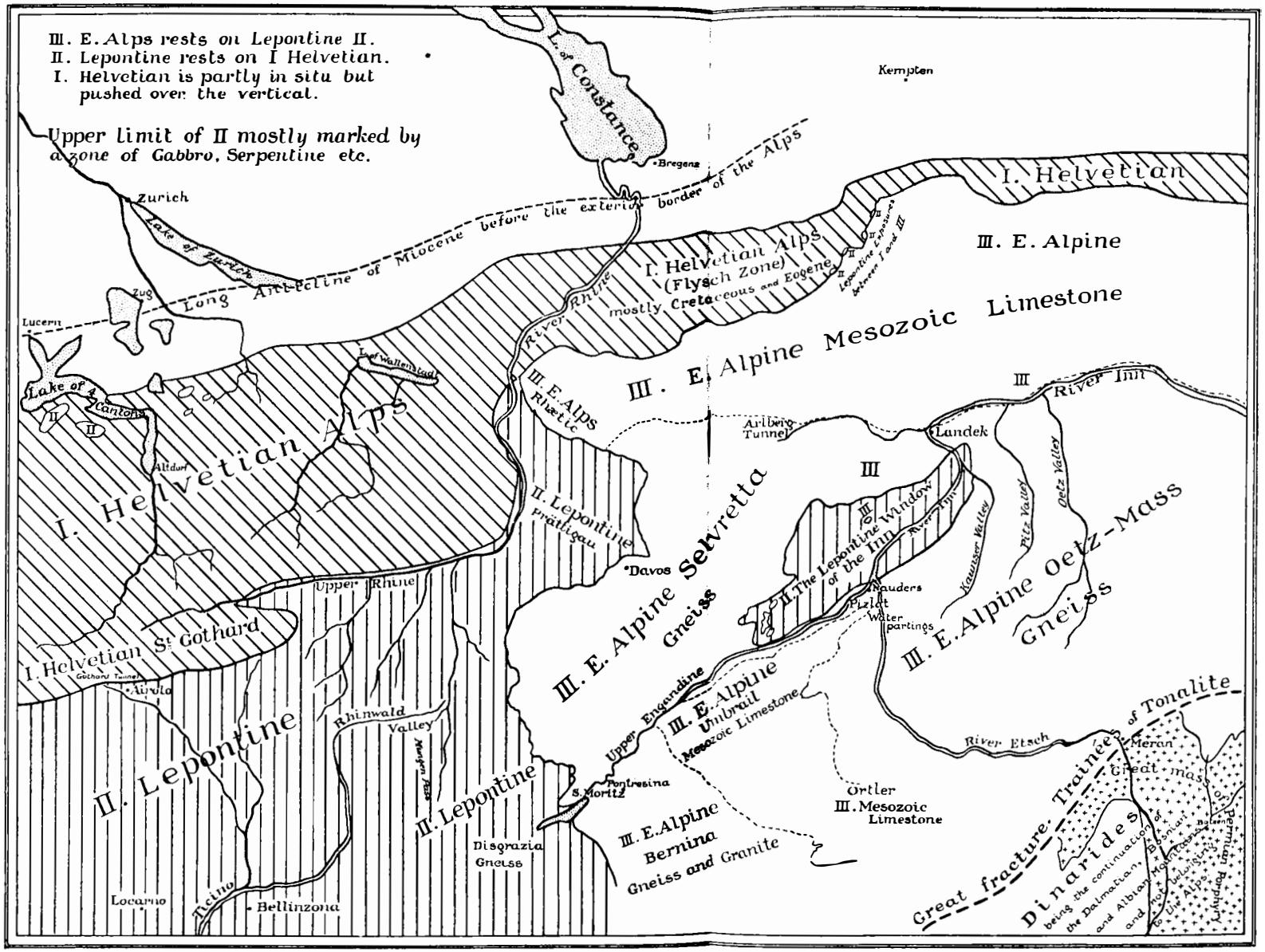
GENERAL INDEX

INDEX OF AUTHORS, ETC.

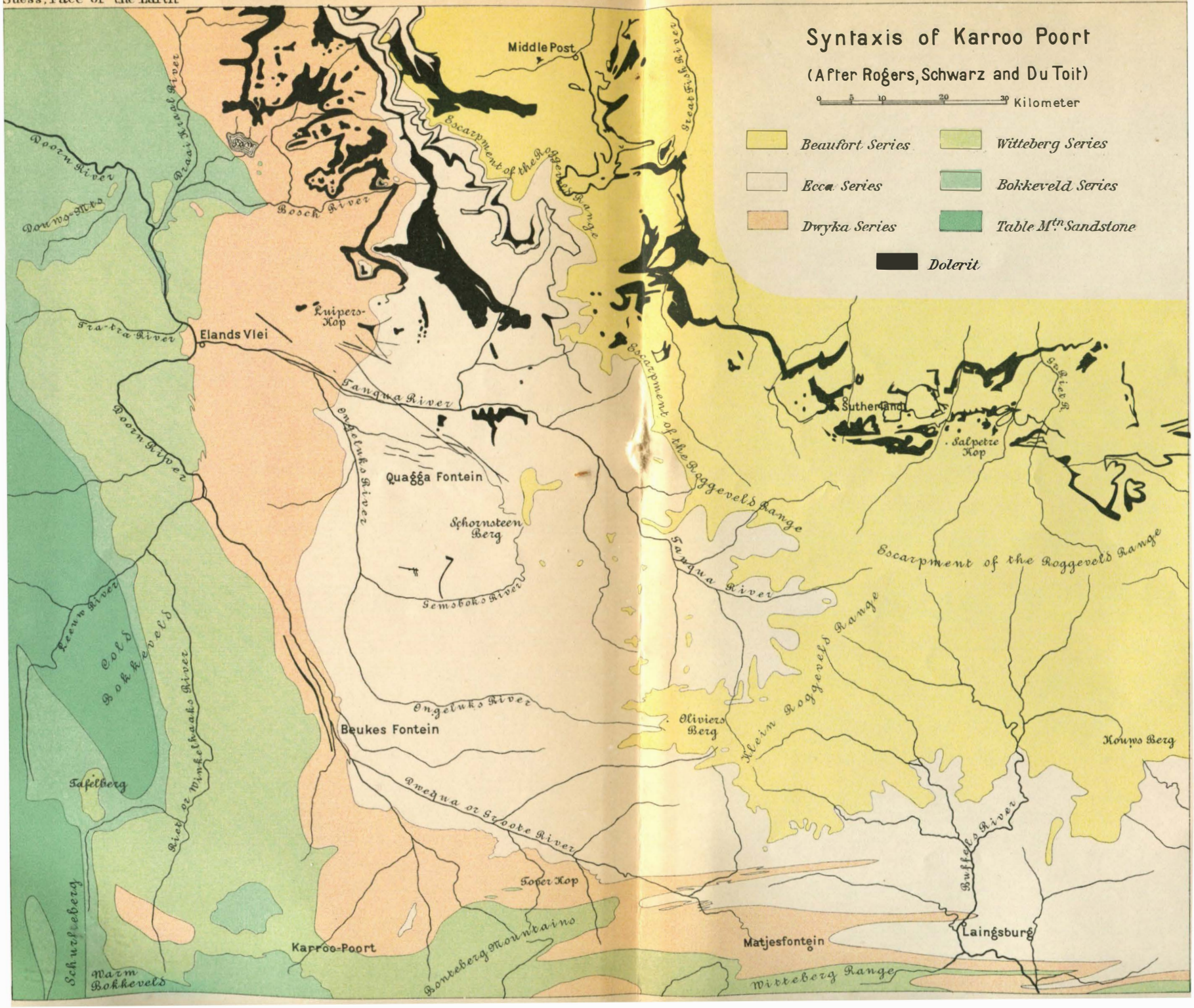
PRINTED IN ENGLAND
AT THE OXFORD UNIVERSITY PRESS

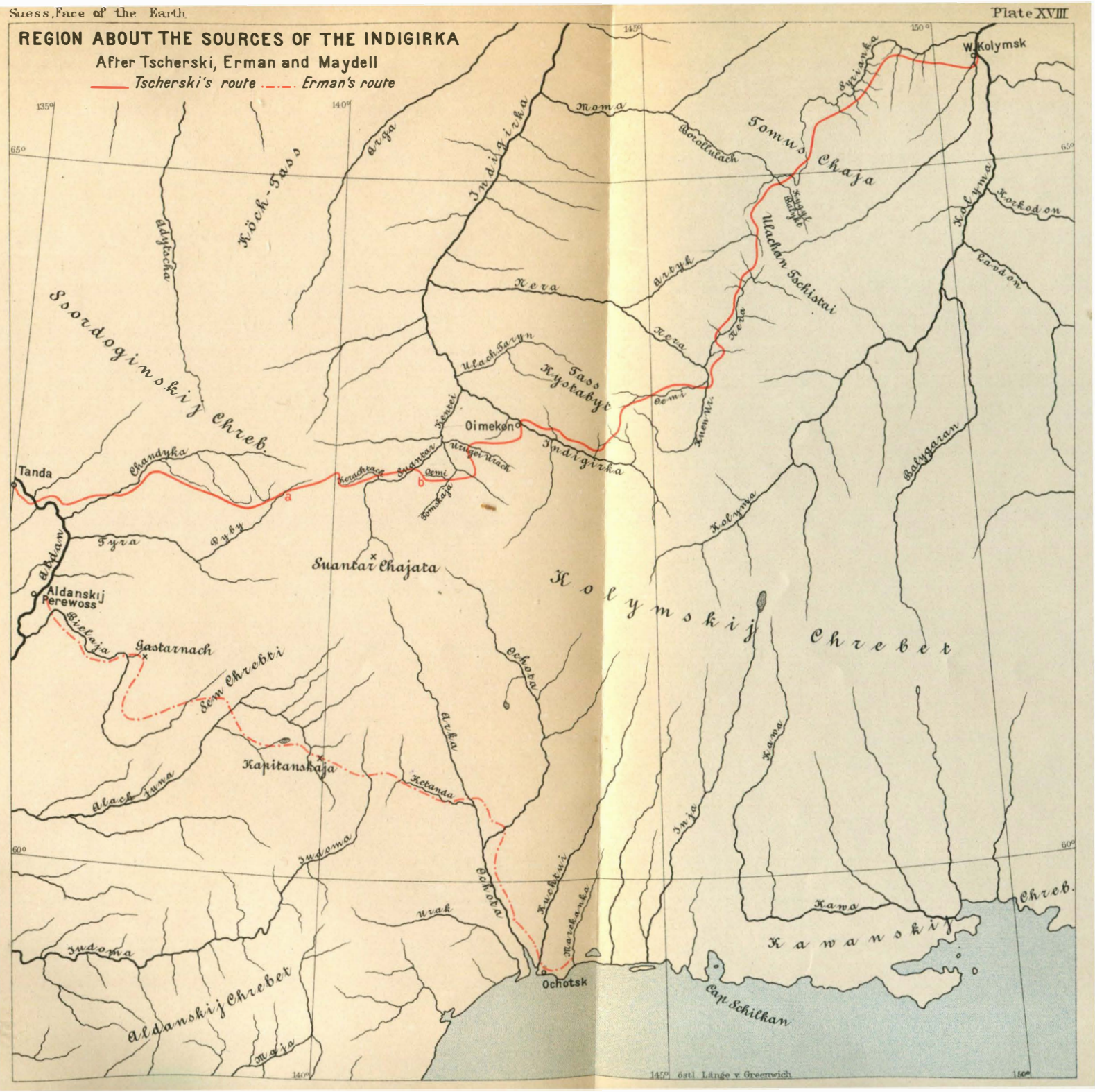


Explanatory diagrams supplied by Professor Suess



SUPPLEMENT TO MAP III


Syntaxis of Karroo Poort
(After Rogers, Schwarz and Du Toit)
0 5 10 20 30 Kilometer
Beaufort Series
Witteberg Series
Ecca Series
Bokkeveld Series
Dwyka Series
Table Mtn. Sandstone
Dolerit
Middle Post
Great Fish River
Escarpment of the Roggeveld Range
Doorn River
Raai Kraal River
Bosch River
Douwa-Mts
Fra-tia River
Elands Vlei
Ruipers-Kop
Tanqua River
Doorn River
Ongeluks River
Quagga Fontein
Schornsteen Berg
Sutherland
Salpetre Kop
Escarpment of the Roggeveld Range
Tanqua River
Escarpment of the Roggeveld Range
Leeuw River
Cold Bokkeveld
Riet or Minkelhaaks River
Gemsboks River
Ongeluks River
Beukes Fontein
Oliviers Berg
Klein Roggeveld Range
Kouws Berg
Tafelberg
Dwequa or Sylooke River
Buffels River
Toper Kop
Schurfeberg
Karroo-Poort
Bonteberg mountains
Matjesfontein
Laingsburg
Warm Bokkevelds
Witteberg Range


REGION ABOUT THE SOURCES OF THE INDIGIRKA
After Tscherski, Erman and Maydell
Tscherski's route
Erman's route
W. Kolymsk
Moma
Indigirka
Arga
Köck-Tass
Adytscha
Ssordoginskij chreb.
Tomus Chaja
Ulachan Tschistai
Kolyma
Korkodon
Kera
Ulach-Tasyn
Kystabyt
Oimekon
Tanda
Chandyka
Aldan
Tyra
Aiby
Suantar Chajata
Aldanskij Perewoss
Gastarnach
Sew chrebet
Kapitanskaja
Ketanda
Judoma
Urak
Aldanskij chrebet
Maja
Kolymskij chrebet
Kawa
Kawanskij chreb.
Ochotsk
Cap Schilkan
140°
145°
150°
135°
65°
60°
östl. Länge v. Greenwich