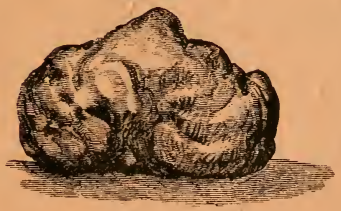
ODDS AND ENDS. No. 22.

Something from the Gold Diggings in Sutherland

BY THE AUTHOR OF 'FROST AND FIRE,' Etc.



Life-size Portrait of a £9 Nugget, Cradled in Helmsdale, April 1869.—P. 21.

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SOMETHING FROM
"THE DIGGINS"
IN SUTHERLAND.

April 20, 1869.

The Sutherland "diggings" are now established, and likely to be worked for some time to come. More than 290 men are paying a pound a month for leave to camp out and work like navvies in claims of 40 feet square; so that they must be earning wages or going crazy.

If many men go away, more diggers arrive daily, and gold is almost daily found at new spots. It is estimated that £6000 has been washed from the shingle of two small burns already; many strangers have travelled to Helmsdale to see the fun, more will go when the wandering season comes. It is therefore interesting to speculate on the probable source of this yellow dust which has made such a stir, which seems likely to yield occupation and profit to skilled men, hard work and little else but sore bones and lumbago to unskilled labour, amusement to tourists, profit to railways, rent to landlords, pain and woe to anglers and deer-stalkers, shepherds and sheep. The source of the gold can only be found by accident, or by intelligent "prospecting." It may possibly be found by considering, 1st, the shape of the country; 2d, the action of natural engines which first quarry, and then shape, and move, and pack stones; such as streams and glaciers which are

working and which have worked in Sutherland ; 3d, the nature of the drift and of the solid rocks.

The geology is best learned from authority. At page 15 of the letterpress published with the Sketch-map of Scotch Geology, by Sir R. Murchison and Mr. Geikie in 1861, is a description of a geological section by Sir Roderick which passes very near the "diggings." In passing from west to east, the Fundamental or Laurentian Gneiss is unconformably overlaid by Cambrian sandstones, which are unconformably overlaid by contorted Silurian rocks, intermingled with granite. On these Silurian beds rests the Old Red Sandstone, "which is formed out of their debris," and which is itself unconformably overlaid by the Lias and Oolite of Helmsdale, Brora, and Golspie. These are the main features of Sutherland geology, according to the best living authority in these matters ; himself a soldier and a genuine Highland gentleman, whom his landsmen honour, respect, and like, for his pluck and knowledge, and for his kindly bearing towards all who strive to follow him in pursuit of science.

Any good topographical map will show the general slope of the present surface, and its drainage areas, by drawing lines about the sources of the rivers. It will be seen that rivers which flow eastwards—the Shin, the Brora, the Helmsdale, and their branches—take their rise amongst high mountains, of which most are near the opposite sea-coast to the north and west. These rivers pass over Laurentian, Cambrian, Silurian, Old Red Sandstone, Lias, and Oolite, and their sea-deltas rest upon the newest rocks in the series. (See cut, p. 32.)

A very slight acquaintance with the country itself shows that the greater part of Sutherland is a rolling plateau of no great elevation, above which, to the west and north, pyramidal jagged peaks of strange shape stand singly and line the coasts. These mountains would be islands if the sea-level were about 500 feet higher than it now is, and, from a distance, they are exceedingly like islands

which line the coast of Norway. On low passes, which would be straits if the plateau of Sutherland were drowned, piles of washed drift still remain.

The following heights were roughly taken with a pocket aneroid in October 1868 :—

	FEET.
Crask.—Edge of the basins of Shin and Lochnaver -	970
Water-parting between Shin and Assynt - -	450
Water-parting between Shin and Strath Fleet, on the railway - - - - -	about 500

It is manifest that this bit of the earth's crust has been lifted and lowered many times, and that all the natural engines which grind and sculpture solid rock have had a turn at Sutherland. The Oolite and the Lias are made chiefly of silt from older rocks packed under water. The Old Red Conglomerate mountains on the east are made of older Silurian rocks, smashed, rolled into pebbles, and boulders and sand ; packed and sorted in the sea, hardened to be rock, and lifted up to be ground down and carved into new shapes. It is possible to pick hard plums out of the plum-pudding stone, and compare them with rolled stones on the beach. The Silurian rocks are sedimentary, so are the Cambrian, and so were the Laurentian upon which the whole series rests. Each younger geological formation proves the partial demolition of older rocks ; each sedimentary bed now above the sea-level proves a rise of land ; every fold in Laurentian and Silurian beds tells of forces which crumpled up the earth's crust like dough. As the Cambrian rocks, which once were buried, now are quarried out of their Silurian graves and stand up the highest of Sutherland mountains, they proclaim extensive "denudation," just as mounds in a railway cutting measure the quantity dug out and carried away. The tallest mountains in Sutherland have, somehow or other, been carved out of the bent and broken crust of the earth ; this particular pattern, on the outside of the ball, has been graven

in crumpled folds of hard rocks, which once were silt like the stuff which the Helmsdale river now rolls down the glen. Whole sets of graving tools have formed a whole series of surfaces, of which the present surface is the last, and it is partially buried already. There must have been Laurentian, Silurian, Old Red Sandstone, Lias, and Oolite bases, on which to pack the newer beds; the work now going on at the sea-coast explains the process, and the section quoted above (page 2) proves very extensive modern denudation in Sutherland. (See cut, p. 32.)

The auriferous drift rests upon, and partially hides, a denuded rock-surface. That is proved.

These may be taken as well-established geological facts. The problem is, Whence came drift and gold?

Before prospecting on paper or on the hill-side, it is well to consider the former condition of this part of the world. Whatever may be said of other lands, Sutherland was covered at no very late geological period by enormous sheets of ice. In travelling north by the Highland rail, the first view of the county is got from the high grounds behind Forres, and thence the distant plateau, beyond the Moray Firth and Cromarty, is overlooked. From Forres, from the shores of the Firth, from Tain, from the shores of the Kyle of Sutherland, and from high grounds behind Fearn in Ross, Sutherland is seen to be a wide rolling plateau, with a general elevation of from 500 to 1000 feet. On crossing the Shin at Bonar Bridge, rocks beside the railway, near the sea, are smoothed and striated. Looking down from a height into the glen of the Shin, on a fine bright day, great gray stones scattered broadcast amongst brown heather suggest a field newly sown. These rocks are ice-marks, these stones are drift. Near Lairg, at about 500 feet above the sea, the plateau is reached; and thence Loch Shin and the brown moors of the interior are seen stretching to the distant base of the west-coast hills. Clibric, Beinnmòr-Assynt, and others, speckled and streaked with snow, stand up

like blocks of lapis lazuli above the plateau of copper and silver. This gorge of Shin clearly was one outlet from a great central sea of ice. The river has quarried its own bed since the ice melted; but rocks and drift in the hollow prove the extinct glacier, mark its course, and measure its depth. The whole plateau, which is seen from Lairg, is dotted with great stones. These, and the heather and peat amongst which they stand, rest upon various kinds of drift. It is seen by the roadsides, in gravel-pits, and in the sides of burns. Every here and there a stream or a road-cutting has cleared the drift and exposed the rock-surface. Where it appears it invariably is worn or weathered; and it cuts through folded beds of crystalline metamorphic Silurian rock all the way to the hills. It is a surface of glacial denudation, partly destroyed by subaërial denudation, but generally well preserved by glacial drift. From the highest point between Shin and Strath Fleet, which is about 500 feet above the sea, the railway descends through a groove, which is too short to catch rain enough to make a river. It contains a small burn. It certainly did once contain a large glacier, an offshoot from the central icy sea. At the top of this groove the rock is Silurian with Granite, lower is Old Red Sandstone, at the end is Lias or Oolite. A carpenter who cuts a groove against the grain with a gouge makes a rude model of this mountain gorge; the grain of the rock is clearly seen from the train: rock-surfaces and sections of drift abound beside the line. All the rock-forms indicate motion down hill eastwards, and a depth of ice equal to the top of the highest hill. Drift left in the groove is glacial drift, overlaid by washed drift in some parts, overgrown with heather, and fern, and grass, where the hand of the railway engineer has spared nature's summer garments, which it is his delight to tear and spoil. A traveller in search of glacial marks can best learn the general system by crossing Scotland in some other place. By starting from Dingwall, a continuous system of fine lines engraved upon the surface of newly-bared rocks, which

have been protected by drift from the weather, can be followed past Garbh, up Strath Bran, to Ach'-na-Sion on the watershed of Scotland ; and by another burn up to Leathad Leacachan, at the foot of Fannich, whence the waters part near Bràigh Mòr. At the head of Strathpeffer, at the new railway cutting under the Raven's Rock, the surface laid bare in the cutting is as smooth as polished marble, and that surface cuts through folds of Silurian rock, which can now be seen in the quarry bent like pleats in a plaid. These rocks are full of broad plates of mica, and glint and glister like beaten silver when the sun shines. The glacial striæ—these lines ruled upon solid rocks—from the sea to the watershed of Scotland, on the bottom and on the sides of rounded hollows, mark the course and measure the depth of Scotch glaciers, as ruts mark the track of a sledge. On the sides of Loch Maree these marks prove that the ice, which went to the westward, must have been somewhere about 3000 feet deep opposite to Beinn-a-Ghuis. It was at least as deep as the glen at the head of Loch Broom ; it rose nearly to the top of Sùl Bheinn in Wester Sutherland. It was up to the level of the monument on Beinn-a-Bhràigh above Golspie. These points being proved, it follows that the whole of this district, during some part of the glacial period, was covered with ice, as a wedding-cake is covered with melted sugar, and that Strath Brora and Helmsdale must have been full of ice like the rest (p. 10).

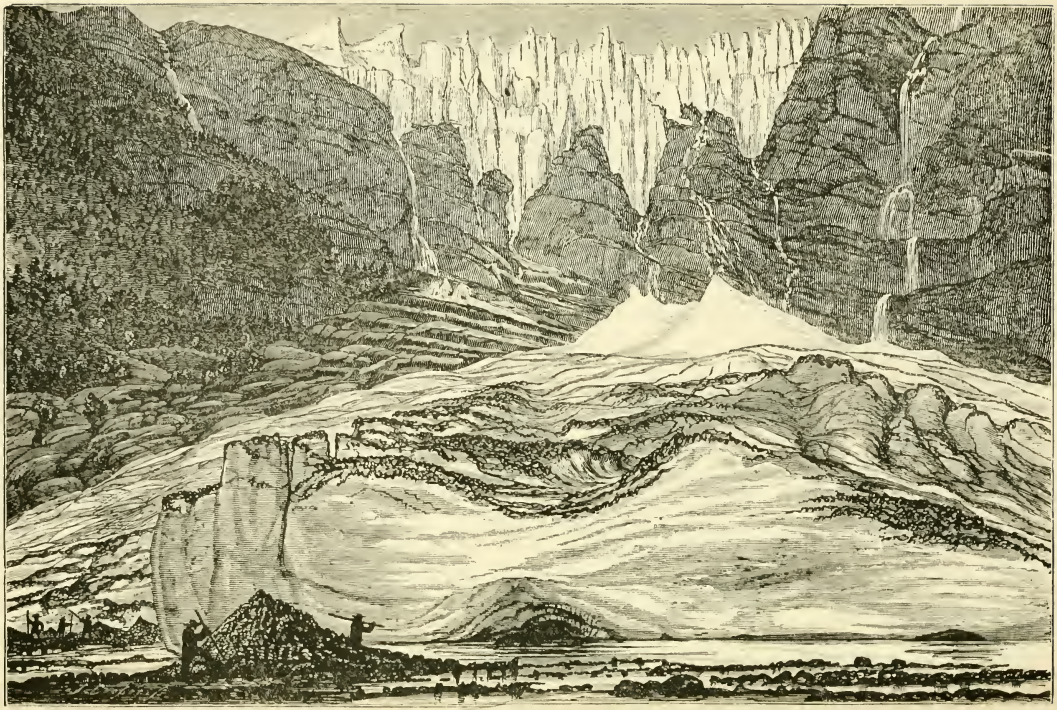
This also may be taken as proved to demonstration.

The ice was there ; but as the ice has disappeared, something is needed to explain its action. To learn the ways of it effectually, some place must be seen where similar ice exists and works in rock-grooves. The journey need not be long, for about Bergen in Norway, opposite to Shetland, within 250 miles of Unst, is a tract in which remnants of a glacial period yet survive in full action.

A few days, a Hull steamer, and a boat, will carry a student to the foot of a glacier which ends within a few miles of the sea at less than 100 feet above the sea-level, and there the ways of old

Sutherland ice may be learned. A tract in Bergen, about as big as Sutherland, is covered by snow and ice which is continually cooling damp warm ocean winds, and condensing their vapours into clouds, rain, hail, and snow. It is the wettest country in Europe. This snow-pile, which is constantly growing on a raised plateau, is continually squeezing itself out like a heap of melted sugar, or tar, or of any other plastic material. When the base of the mass of crushed and frozen snow gets to a hollow, crushed ice is squeezed out and moves slowly down in the rock-groove, where it becomes a glacier. When the base comes to a cliff, the ice falls over, breaks, and mends. In one branch of the Sogne Fjord, when the weather is fine and hot and still, the loud roar of falling ice echoes amongst the hills like the sound of a cannonade, and is heard at a distance of twenty miles. Arrived at the place whence this grand music proceeds, the edge of the upper ice-field is seen at the edge of a cliff a couple of thousand feet above the glen, glittering like a crown of diamonds and sapphires. The ice is jagged, torn, splintered, riven to the shape of glass when it bursts on the glass-house floor. From this edge, at short intervals, masses of ice, as big as Dunrobin Castle, or the houses in Golspie and Helmsdale, tumble down, crashing, and break into dust, while a thundering clamour of avalanches goes rolling down the fjord, echoing backwards and forwards from hill to hill, and growling to sleep at last.

Beneath the hollow whence the ice falls, a pile, which may cover a square mile or more (*see* cut, p. 8), moves on the very same principle which governed the snow-field above. The base of the pile spreads out like a fan, the parts of the mass squeeze out like a snowball thrown against a wall; and so the great mass, and the little mass which grows from it, slide down to corn-fields from the high plateau, which is buried in ice. Two or three times in an hour, a mass of ice as big as the planted side of Beinn-a-Bhràigh, and somewhat like it in shape, is crushed into some new form by



SKETCHED SEPTEMBER 3, 1857, AT THE HEAD OF FJÆRLANDS FJÖRD.

its own enormous weight, and it takes a start down hill with a fearful crunch, that proclaims aloud the giant power of this little descendant of the greater snow-heap, whose edge glitters in a corrie above the main glen. By travelling to this spot, any man can learn in half-an-hour how Sutherland ice behaved. Like the Bergen ice, it started where rivers now rise on the watershed, and it slid down where rivers now flow, moving at the rate of a foot or two per day ; it fell over cliffs, and it covered the whole land like a white pall. The same thing may be seen on a far larger scale by sailing to Iceland, or by travelling to Switzerland. In Greenland, within six days' sail, the same thing is now going on about the latitude of Shetland, and there the ice country now is about as large as all India. Ice many thousand feet thick is spread over all the hills, and fills every glen as it filled those of Sutherland once upon a time.

Such being the nature of ice moving on shore, it follows naturally that it grinds and grooves the rock on which it slides. If Fionn or the Hrimthursar, the giants of whom Sutherland men and Scandinavians tell tales, were to drag Clibric down to Helmsdale on a sledge, the moving mass would leave a track; and from tracks it is certain that masses of ice far bigger than Clibric did slide to Helmsdale down the glen. The woodcuts may give some faint notion of Sutherland as it appeared when full of ice. This might be Strath Fleet, or any other strath that comes down from the plateau. But the gold problem is in waterworn drift with the gold itself, and it must be dug out of drift.

On the small Norwegian glacier above described a great many small streams and rills fall from the upper levels, and throw down broken stones. From the rocks which tower above the ice, stones fall in frosty weather as they do from Scotch rocks. Some of these go through cracks and get under the ice, others rest upon the ice, others get into channels worn on the top of the ice by rills, which grow there when the sun melts ice, and these flow down to the

SKETCHED SEPTEMBER 6, 1857. A GLACIER IN JUSTEDAL IN BERGEN, ABOUT TEN MILES LONG.

If this be taken to represent Helmsdale, the Caithness hills are to the right, and the diggings G about the edge of the ice. Gold has been found to the left below G, and beyond these hills in the next strath.

end of this glacier in smooth slippery grooves. But as the whole mass of ice is moving, the whole load upon it—the stones and rivulets, slippery grooves and all—are slowly moved in the same direction. The stones make "drift," and each process gives a different kind.

Stones which are under the ice are pushed by it, and they are ground and grooved upon the rock beneath.

Stones which rest upon the ice where they fell are carried down as safely as on a sledge, and reach the end of the glacier with sharp angles, as they fell when they were quarried. Stones like these are piled at the foot of every Scotch cliff as scaurs or cairns.

Stones which get into watercourses on the ice are there rolled, knocked together, and tumbled about, as they are in any other watercourse, and they take the shape of water-worn shingle. These are finally shot out at the end of the ice-burns, and then they form conical piles about the lower end of the glacier (*see* woodcut, p. 8).

Stones which get into watercourses under the ice are rolled in tunnels under an arch of ice, over a hollow of stone, which differs in no way from hollows exposed to the sky elsewhere (*see* p. 8).

Glacier drift, then, consists of stones, and sand, and mud, and gravel, which have all been subjected to certain mechanical treatment, and which have all moved down hill from their source towards the sea.

A practised eye can easily track old glaciers by drift, as well as by ruts.

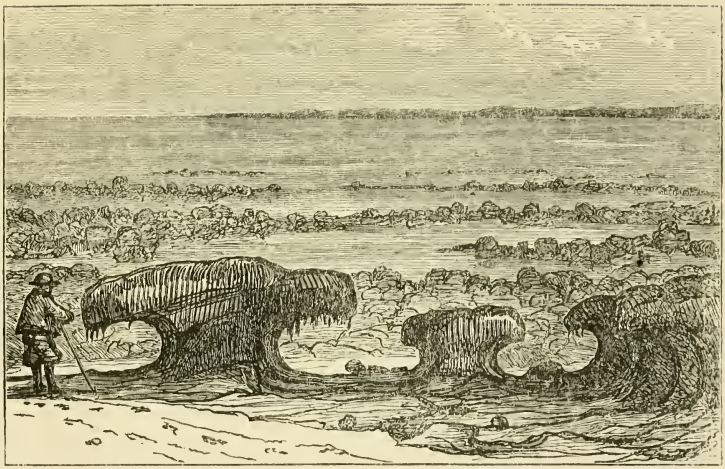
Drift in North America, in Scandinavia, and Northern Europe generally, in the British Isles, in Scotland, and in Sutherland in particular, consists of clay of various colours; in which large boulders, smaller angular stones, and sand, are tightly packed, without reference to size, shape, or weight. This drift, which amounts to a small geological formation, generally rests upon solid rock, whose surface, when newly uncovered, is beautifully smoothed

and grooved. This undisturbed glacial drift, which is compact and watertight, and sticks hard to the polished rock, is often covered by beds of washed shingle, gravel, and sand, arranged, sized, and sorted in various ways.

Part of the older drift has been "denuded," and the fragments sorted and re-arranged by small glaciers, by running water, by lakes, by the sea, by road and railway makers in Scotland, and by gold-diggers in Kildonan Burn. It is often possible to specify the agent which did the work. Here is work done with a pan, or with a cradle, or with "Long Tom," or with the long sluice; in work done long before by Kildonan Burn in a rock-groove. Here is work done with pick and shovel, cart and truck, in the glen which leads to Golspie. Here is sea-work, a raised sea-margin, which is known at a glance from its likeness to the actual beach. Here is the delta of a burn in the sea; here the ancient delta on the ancient raised sea-margin Δ. Here is a Pholas shell in the hole which he has drilled; there, 40 feet up, the face of a cliff is honeycombed with similar holes. A dry river-course and a raised beach are easy to recognise; and moraines tell the story of melted ice to those who have learned to read the book of nature.

A walk along the beach to Brora is through a museum of stones carried from the interior of Sutherland, and now left rolling upon the newest rocks in the geological series. Oolite and Lias;—rocks which contain beds of coal and oil-shale cropping up between low and high water mark, are being worked into "a plain of marine denudation" by waves and boulders. The soft rocks are grooved, and channeled, and undercut, and drilled into pot-holes, and look like mushrooms and monsters. This surface contrasts with glaciated surfaces. The motive power is in the waves; the grinding tools are stones moved by them, and the stones are drift. At Brora, amongst the shingle, are samples of all kinds, rolled into one shape.

Bricks from the houses, furnace-slag with cinders in it, bits of



Sketched April 24, 1869.

A plain of marine denudation. Rocks worn by waves, shingle, and boulders, between high and low water marks. Between Brora and Golspie.

Compare woodcut, *Siluria*, p. 457. 4th edition.
Gold diggings at Zarevo Alexandrofsk, in the Ural, where these rock-forms occur, associated with auriferous drift.

Oolite and Lias from the cliffs, great stones of Old Red Conglomerate from the near hills, samples of crystalline Silurian rocks, Granite and Quartz :—there they rest while the tide is out, in grooves and pot-holes : there they begin their endless work when the tide flows ; and when the wind blows and the waves rise they work merrily. They are all more or less egg-shaped and smooth. Forty feet up, or thereabouts, the cliffs are honeycombed by boring sea-shells ; at the same level are caves ; and on the opposite side of the water, in Cromarty, are similar raised caves, which Hugh Miller made classical long ago. The actual sea-margin proves the title of the elder brothers who have risen to be terraces and road-ways, and who are to be promoted to be railways, vice roads disused. On the second raised margin, about the level of the caves, are ancient Pictish towers ; and from the freshness of sea-marks on these cliffs, it is probable that the towers were made when the sea was close to their base,—say forty feet higher than it is. The Cinq Ports prove a like rise in England.

Returning to Golspie, the drift at the mouth of Golspie Glen, where the new rail is to cross, is about 100 feet thick, and is stratified gravel in the banks ; but in the actual watercourse are large stones, many of which retain striæ, while others, though worn, retain the peculiar subangular form of boulders moved from glacial drift. Most of these big stones are fragments of Old Red Sandstone and Conglomerate from the nearer hills, but many are crystalline Silurian rocks and Granites. Here a small glacier came down from the interior, and here the burn washed the drift ; and here, as it seems, the sea arranged the moraine, and the delta when the sea was about 200 feet higher than it now is. With this section to give the structure of the low ground, a glance at the hollow towards the Fleet shows that this was a bay. In the woods about this level the old sea-margins are marked by sweeping ridges of great boulders, which were beaches, and by piles of sand and gravel, like those which now line the coast. Beyond

Brora these coast-terraces are marked by farm-houses and green fields, which turn into heather where the curved hill-sides come down to the straight bench-marks of the terraces. These form a vast amphitheatre, through which the Brora has made a cutting, and in it a series of low green haughs. The stratified shingle is seen above the pools in banks which the river is undermining, and the newer rock on which all this drift rests is seen at Brora. The bridge spans a bit of rock-cutting done by the river and the sea, and the nature of rock-grooves and pot-holes, and all other water-marks, can be seen from the bridge ⌣.

In the jaws of Brora Strath, below the lake, are ice-marks. These are conical mounds of drift, which were certainly poured from channels on the top of the big glacier, which must have come down from Clibric along the strath. Of these mounds there are several ramparts, which were terminal moraines. They mark the end of the dwindling glacier at different periods, and they consist of rounded water-worn stones of all sorts and sizes, mixed with sand, gravel, and mud. To see the process of their formation, it is only necessary to watch the end of a gold-digger's trough. The washed stuff is there shot out, and forms a conical pile of the same pattern as the Brora moraine-heaps, and the moraine-heaps at the end of the Sogne Fjord in Norway ∧ ∧. (Page 8.)

Gold has been found in burns which flow into Strath Brora, and that strath may turn out to be as rich as the others; but the worst place to seek for more gold would be in the washed dirt of the old glacier, at the end of the trough in which the Brora now flows, and in which a glacier once slid down from Clibric to the sea.

On the hill-side beyond Brora a small stream has cut a deep winding gash. Because the end of it is higher, this bit of river-cutting is older than the work at Brora Bridge. The cut ends suddenly at the uppermost step on the amphitheatre, and thence the water flows to the sea over loose drift and softer rocks, which

it has scarcely marked since the land rose. That marks another ancient sea-margin, when the sea was at the end of the upper rock-cutting, and sea-water protected the lower ground from the burn. Looking eastwards at the profile of the land towards Helmsdale, five distinct benches are clearly seen, with the sea at the foot of the lowest. The same forms, marked by shape and by colour, recur, over and over again, all the way to Helmsdale. Each small watercourse has cut deeply into the rocks above a certain level; each stream has spread a delta, and cut a shallow hollow through the loose drift; and the beach everywhere is strewn with great stones, far too large for burns to move, for sea-waves can only destroy them by battering their ramparts with pebbles and sand. These terraces rise about 400 feet above the present sea-level.

At the top step the ground is made of yellow clay, with numerous angular and subangular stones of sorts packed in it. On the beach, half-way between Helmsdale and Brora, are vast blocks of Old Red Conglomerate, as big as small houses, broken and worn by waves and winds into the most fantastic shapes, crusted with shells and fringed with sea-weed. Amongst these, which belonged to the hills on the coast apparently, are specimens of every rock in the geological series of Sutherland. These again rest upon a "plain of marine denudation," which cuts through beds which dip about south-east away from the foot of a cliff which is the side of the next step carved out of the solid by the sea.

These facts, and a great store of facts like them, gathered in many lands during many years, are not easy to explain so as to reconstruct a chapter in geological history, but this explanation seems best to fit the facts.

Scotland and Scandinavia have certainly risen from the sea in late geological times. If they rose in the track of a polar current moving towards the south-west, blocks of iced land, raised in an iced sea, would naturally gather snow, and resemble Greenland whose shores are now washed by the polar current which flows

south-west there. But the gradual rise of Scandinavia and of Finland, and of the low lands of Russia, would gradually cut off the old polar current, and so transfer it with its climate to Greenland. In this case the gradual rise of land in Sutherland would coincide with the dwindling of glaciers, and the equatorial current, which must no longer be called the Gulf Stream for fear of controversy, would speedily banish a local glacial period from Sutherland and Scandinavia to Greenland.

Now, to see how this bears upon Kildonan gold.

At Helmsdale, near the mouth of the river, and in the jaws of the glen, are more heaps of stuff like the Brora moraines, and the Helmsdale leads back to Beinn Ormen* and Clibric again. Gold has been found in burns which come in from both sides of the Helmsdale strath, in burns which come from the Red Sandstone, Granite, and Silurian hills to the south, and in those which come from the Caithness range on the north. The source of the gold has not yet been found in Helmsdale. The gold is in stuff sorted by modern burns, and it is now worked in watercourses which come down from the Caithness side of the Helmsdale glen. These are branch burns, which rise amongst bare Granite and Silurian rocks, and flow down the side of the main groove towards the main river. These branch burns have done a good deal of digging and carving on their own account; they have done more than the main river; so they have worked longer. The Kildonan Burn has carved a trench in crystalline Silurian rock from the place where the chief diggings are now carried on down to the farm-house. It is about 20 feet deep below the road; it is about 80 feet deep behind the new township, which has been christened Baile-'n-oir, or Golden Town. In this it is like other burns, and marks a gradual rise of land at this spot. Where the fall is rapid, this rock-groove is now washed clean, or left with a few large stones on the bottom. Above this bit of river-cutting is a "flat," in which a lot of rolled drift settled, probably long before the rock-cut was deepened by the stream

* Òr-méin = Gold-mine.

ROCKING THE CRADLE.

Section of a "claim" in Kildonan Burn. Waterworn drift arranged by running water in a groove carved in the edges of disturbed metamorphosed bent beds of Silurian rocks. Most of the gold is found near the rock amongst the biggest stones, and in chinks in the rock.

below the flat. The water in this "flat" or "creek," now meanders through rolled drift, washing it, carrying off the lighter parts, and leaving big stones, heavy iron-sand, garnets, and gold. Little gold has been got out of the actual watercourse, but some was found there at first, and that find started the diggings. For about a mile the whole of this waterworn drift is being turned over and washed in various contrivances, and every one of these engines is worked on the same principle as the natural engine which washed and sorted this drift.

The simplest engine is the tin basin. A spadeful of stuff is turned in, and then the pan is dipped into water; the washer shakes the pan, and tosses up the mass; the stuff, being free to move, falls; and the heaviest stuff falls fastest. First the mud floats away, then the big stones are picked out and thrown away, then the sand is washed away, and lastly, at the bottom of the pan, a small heavy stratum remains, in which a lucky man may find a speck or a scale of yellow gold, or a nugget as big as the half of a split pea. The cradle acts on the same principle; so does Long Tom. Each is a contrivance for rocking or raking drift in flowing water, with a still pool for the heavy ore to settle in. The long sluice, however, is the best imitation of the burn itself, and the long sluice does most work. It consists of a long wooden trough with a smooth bottom, ending in a bit of crossed grating like the floor of a boat. Beyond this is a longer trough to carry the water down to the burn. A small lead is made, and a small fall comes in at the head of this wooden model of a Highland strath.

The washers dig into their claim till they get to the solid rock, and if there be chinks and crannies in the rock they quarry for some feet. The drift so moved is tossed up into the trough beneath the miniature waterfall, and a man stirs it up with a claw till the shingle is as clean as shingle on the beach at Brora. Stones as big as turnips and big potatoes are forked out from under the fall, and these are tossed into a heap. Gravel to the size of small potatoes

rolls down to the end, hops over the grating, and trundles down the long trough to the miniature delta, where the stones stop under another miniature fall and form a conical heap there. Mud and sand go the same way, but the mud goes down the burn to the main river, and spoils the fishing. Very little quartz or vein stuff is to be found in this drift. At the end of the day, or sooner, the trough is examined; the grating is lifted, and the stuff which it caught is swept back to the upper fall, and there washed by a smaller stream. The gold, the iron-sand, and the garnets which remain, are found at last at the upper end of the trough, and these are separated in a tin pan, or by some other process. Starting from the foot of the upper fall, the water moves gold, which is about eighteen or nineteen times heavier than water, a few inches: the same power applied to stones of like dimensions, to coarse grit and gravel, which may be two or three times as heavy as the water, moves them ten or twelve feet along the smooth board; and the fine sand and mud, whose particles have little weight in proportion to surface, are washed right down to the big river, a mile away. It is manifest that water working in a trough a couple of miles long, for a vast number of years, must do similar work. The old hands know it, and they look out for pockets, and reefs, and bars, and bends, and flats; they work claims there, and get their reward. By turning over about ten thousand cubic feet of a claim $40 \times 40 \times .6$ feet, three men may manage to get dust enough to fill a half-ounce vial, or say a thing as big as a cherry or a bullet when it is all melted. The day's work of the whole band, working like navvies, was given to the Duke of Sutherland in a small vial half-full. When such is the nature of the work, it is no wonder that raw hands fail to make profit. To wash gold, a man must be skilled in practical hydraulics; to know where to seek, he must know the nature of burns; to find the source of the gold, he must be wise in other ways. No one has been wise enough to find a British quartz-vein with a fortune in it thus far, and a good many people have lost their time in the search.

Experienced Australians have been "prospecting." Their plan is to work up to the source of the branch burn, and seek amongst the Caithness hills, but no gold-mine was found, even on "Tom Tiddler's guarded ground," which the diggers invaded in spite of fines and penalties. A walk over the hills to the upper Soisgeul Burn leads to another scene of busy work, and to a suspicious vein or bed of decomposing rock, in which it is hoped that gold may exist. In this burn grains of gold are generally larger, and drift finer, and here a lucky boy picked up a nugget worth nine pounds sterling, and bigger than a bean. Two or three small nuggets, consisting of gold and quartz, which were also found here, seem to prove that the gold came out of quartz-veins somewhere; other small nuggets indicate granite-veins. But as these nuggets, and all the gold found, are as much water-worn as stones in the burn and on the beach, the source of the gold would seem to be far away. These small rivulets never quarried all the stones which they have rolled and sorted. But as this glen was full of ice at some time, a good Helmsdale glacier, like one of the Norwegian family (see page 10), was strong enough to quarry, grind, and carry enough of drift to fill the burn to the brim, and supply the sea with beaches. In fact, behind Kildonan Lodge, in a couple of gravel-pits, a section of glacial drift can be seen. It is firm, compact, closely packed, angular and sub-angular stuff, without a sign of stratification, without any definite arrangement as to size, and with occasional scratched stones, which tell their history as plainly as hieroglyphics do to men who can read them. The whole of the terrace on the north side of Helmsdale Strath was the lateral moraine of the Helmsdale glacier which came from Clibric, the pass into Strath Halladale, and thereabouts. This point may be about 300 feet above the present sea-level, so it was under water when the sea was up 400 feet, and it looks like a terrace shaped by a sea-loch. About the forks of Soisgeul Burn, where Allt-na-beist comes in, another terrace at about 550 feet above the sea-level is made of sand and shingle, resting on Silurian

rock. Through and across this terrace, which seems to be an older sea-margin and a moraine, the burn has cut a deep passage down into the rock. These high terraces are not all made of water-worn materials, but they have been washed into the outer shape of terraces by water, probably by the water of a long fjord or strait, and then running water has made a cutting, and set to work to roll glacial drift into boulders in a rock-groove which is but an enlarged gold-washing trough.

The Helmsdale glacier being an established fact, it seems that the lateral burns have been washing cuts made through lateral moraines on both sides. The result is a little gold gathered from great heaps of glacial drift, of which a small portion has been rolled and sorted by each burn in a long rock-trough, in some of which Australians are at work with their wooden troughs.

But where is the probable source of the gold? Where are quartz-veins to be sought by the light of this knowledge of glaciers?

A glance at the map suggests Clibric or the whole plateau of Sutherland. Gold has been found in the straths of Brora and Helmsdale; glaciers came down both these glens from the region of Clibric; the beach about the mouths of these straths is made of stones which may have come from these regions. No stream could possibly wash down great blocks which now rest on the Lias and defy the waves. Terminal and lateral moraines still rest upon grooved rocks where the ice packed them. The whole plateau is drift.

It seems to be proved that ice must have carried gold from the place whence it carried the drift.

If this argument is good, gold may be found in all the burns which flow from the Dìreadh Chat = the Cat's Climb, or Rise of Clan Chattan—or perhaps in all burns that have washed northern drift.

For this ice question leads still further afield. This district

has risen slowly from the sea, and when the sea was at the ancient margin, 400 feet up, east-coast glens were sea-lochs. Then side burns formed deltas in sea-lochs, and these Δ flats remain as fine green spots below rock-grooves, which the side burns have cut in the hill-side. Baile-'n-oir stands on one, another is at the mouth of Soisgeul Burn. These are the bits which farmers wish to preserve for pasture, and for warm shelter for their sheep and lambs, and which old Australians long to break up and wash for gold. There can be little doubt that these washed deltas, which probably formed in a still fjord, will yield well when they are tried. But that is not all. The sea has been up to all the low passes which separate the mountains of the west coast, for rolled water-worn stratified drift is in them all. At Ach-na-Sion, in Ross, these gravel-beds are 700 feet above the present sea-level. But the sea has been still higher, or the whole land was overrun by a great polar glacier, for great rocks are perched where no other engine could place them. At the foot of the peak of Fannich, about 3000 feet above the sea, is a stone called Clach Mòr na Biachdail = the great belling-stone, about which the deer now congregate, and fight, and bellow, and wallow when the frosty nights begin. It is a stranger in these parts. On the shoulder of Wyvis, at about the same height, are strange blocks placed where they could not possibly roll, and so throughout Scotland wandering blocks are left on high watersheds. At similar heights in Scandinavia like phenomena abound, and these are associated with grooves and striæ, which seem to prove the movement of heavy ice from N.E. to S.W. over the British Isles. It does not appear clearly whether these grooves were made by ice adrift in an arctic current, or by ice sliding bodily from the Pole towards the Equator. On these points the learned are not yet of one mind. But the fact is certain that northern drift has been carried by ice of some kind down into Poland, into the American prairies about St. Louis, to Washington, and probably to like

latitudes elsewhere, to California for instance. A curve drawn in the direction indicated by these high British striæ, namely N.E. from Sutherland, passes near the Loffotten Islands, where grooves on low islands point N.E. to the country about the Alten and Tana. There, on a watershed on a pass below a hill of moderate height, on a plateau which is very like Sutherland, another set of grooves point at the Arctic Ocean and St. Petersburg. Thence all the way to St. Petersburg grooves and northern drift tell the same tale. They declare that northern ice moved from the northern end of Scandinavia south-westwards to Scotland, south-eastwards through Finland. But the strange coincidence in this golden chapter in the history of northern drift is, that the river Tana in Russian Lappland yields gold, and was the scene of busy digging and unsuccessful prospecting for quartz veins in the autumn of 1868. According to this larger view, Sutherland gold may have come from Lappland if it belongs to the northern drift; it may have come from Clibric if it belongs to local glacial drift. It did not all come out of Caithness into the burns which are worked now, for some gold has been found in the next Sutherland strath beyond a high ridge. If a quartz-vein is found, it may be worth very little, for the small quantity of metal found may have come from many poor veins in a vast mass of demolished rock, of which all the drift in Sutherland is but a very small remnant. It is quite possible that a nugget which now is in the burn at Kildonan may have sailed on an iceberg from Scandinavia to the shoulder of Clibric when the sea was high, and may have slid thence with the local glacier when the land rose. It may have been left on the hill-side in the lateral moraine when the glacial period ended in these regions, there to remain at rest till the local burn cut through the glacial drift and rolled it down hill. There in the flat it certainly rested for many a century, till a Sutherland man who had been in Australia returned to his native glen, with the firm conviction that he would find gold there. Then the Sutherland Highlander, re-

turned from the Antipodes, turned up the other rolling stone, realised his dream of many long years, and proclaimed his find. Then from all quarters human drift came trundling back into the empty dale whence men were moved during a glacial human period, where they were welcomed by warm hearts and a genial thaw. There they now are busy wanderers, busily working amongst wandering stones, in quiet burns and grassy straths, where deer used to dispute the grazing with sheep. There grouse now crow lustily beside the golden town which sprang up like a mushroom in the heath. Sheep, used to the din of rockers and the hum of voices, are beginning to browse quietly instead of scampering off to the hill-tops with flourishing tails behind them. As time wears on, in a year or two the iron horse, which is making tracks to Helmsdale, will make tracks up the straths and over the hills to the haunt of the worm, the dragon, the water-horse and water-bull, creatures less marvellous than the fiery dragon which is about to overrun this haunted land. When he does come, the track of the fiery steed will be found to coincide with the track of the glacier which helped to carry golden drift to Kildonan as a bait for men.

Truly the true story of a Sutherland nugget, and the adventures of the men whom it has drawn from the ends of the earth, would make a stranger history than any wild tale told by a Sutherland fisher's hearth of a winter night.

"Ex uno disce omnes."

A man with a strong Yankee twang being interrogated, answers that he is a native of Sutherland. He has been wandering about America for fifteen years; he learned gold-digging in California, and after a while spent at that work he kept a school in Texas for five years. Tiring of that, he came to England, and became a porter on the London and North-Western Railway. Heard of the diggings, and thought he would like to try his hand, so came to Kildonan and got a cradle. Can speak Gaelic still, and English with a considerable twang; can speak Italian, which sounds re-

markably like a mixture of Spanish, Latin, and Portuguese, all ill-pronounced and misapplied. The poorest digging he ever tried. Shan't stick to it much longer, means to clear out.

Cheerful grin, pleasant greeting, and farewell; and so to another.

Very poor diggings these. Went to Australia at fifteen years of age, been to New Zealand, to California, and to British Columbia; was up near Salt Lake City, digging not long ago; heard of this find in the south, and came up with a mate, more for the fun of the thing than for any other reason. "Yes, it's hard work; yes, and not much to get out of it, but there's nothing like life in a tent. You see it's the same inside as out, so when you come out in the morning you don't catch cold. Very comfortable here, but shan't stay long."

Greetings, salutations, grins, smiles, hat-touching, and part for another claim.

Two swells, in broadcloth and gold watches, home to see their friends in the old country, mean to go back to the colonies. Heard of this in Edinburgh, and came up to see the fun. The people over the water will be so much interested in a brooch, or a ring, or a pin, dug out of a creek in the old country. It seems so strange like. This is a very poor digging. The best men can just make wages. Shan't stay much longer. But if we could get a claim down there (in an old delta on one of the old sea-margins) would not mind stopping a bit.

Good luck to you! Good-bye.

So it is easy to prospect up and down the burns, and extract knowledge from pleasant, open-eyed, cheery, hearty wanderers, who are all chips of the old British block, and hard grit if they be rolling stones. But when it comes to the turn of a yellow-faced heavy clod of a newly-cradled nugget, who has not got a bit of grit in his composition, or a word to throw to a dog, how is it possible to extract knowledge out of him? All that he can tell

about his wanderings and birthplace is soon told. He has been abominably ill-treated by his neighbours, who are hardy, good-for-nothing Scotch pebbles, and won't rest anywhere. Did his best to stay where he was and let them roll away, and did let a whole lot of them roll over him and go to sea as sand. Their marks are on his podge of a yellow face still. Had got into a nice bed, and hoped to be quiet there, when a restless digger shovelled him out and washed him; and here he is, king of stones, as bright and important as a new baby. Where did he come from? Believes that he came out of a lot of glacial drift, a long time ago. Where did he come from before he got into the drift? The king of stones and men, the yellow dwarf who reigns wherever his kind are scarce, seems to wink his eye, and snore out,—"You wish to know where nuggets grow?" "Speech is silver, silence is gold."

And there the problem must rest, for the nugget answers query with question, and keeps his own counsel like a true Scot.

Nobody knows where nuggets grow, but they always seem to turn up when they are wanted, as baits to lead men to some good end. They will now help to make the Sutherland rail, and feed fishermen, who may sell fish for gold. If some men can't dig nuggets out of golden drift quite so well as old hands, they may turn their hands and brains into current coin by other means. These are the views of an amateur.

The views of Sir Roderick Murchison on the origin and distribution of gold are especially worthy of attention; they are stated with exceeding clearness in the fourth edition of *Siluria*, 1867, p. 448. Conclusions founded upon the author's very extensive knowledge of the subject, and on facts and arguments of great value and weight, are at page 472. Of these conclusions the first and fourth bear upon the discovery of drift gold in Sutherland, and on the possible discovery of gold-mines there. They are as follows:—

"1. That, looking to the world at large, the auriferous vein-stones *in the lower Silurian rocks* contain the greatest quantity of gold."

"4. That as no unaltered purely aqueous sediment* ever contains gold, the argument in favour of the igneous origin of that metal is prodigiously strengthened; or, in other words, that the Granites and Diorites have been the chief gold-producers, and that the auriferous quartz-bands in the Palæozoic rocks are also the result of heat and chemical agency."

These conclusions point to lower Silurian rocks which in Sutherland are at the head waters of rivers which flow eastwards, and which are at the heads of nearly all the rivers in Scotland, as probable sources whence Scotch drift gold was derived. They point to Clibric and to the Catamountain Rise, as the place whence gold and drift in Helmsdale and in Strath Brora may have travelled with ice and water. But the same facts and conclusions also point to Shetland, to Northern Scandinavia, and to Russian Lappland, where rocks are Silurian and Granite, and where river drifts yield gold.

A discovery announced in the *Scotsman* of April 29, 1869, points northwards and to distant lands. Gold has now been found in Unst in Shetland, in the Ness Mure burn. The discovery was mysteriously announced from a cliff to Andrew, a fisherman, and a decent lad who would not tell a lie, by a voice which proclaimed, "PLENTY GOLD ABOUN." Andrew, and others to whom he told his tale, sought, and found a good lot of iron pyrites; but an experienced Australian dispelled that golden dream, and found a little gold by "fossicking" in the burn itself. The voice may have spoken with a colonial twang and a view to its own interest, or it may have been the voice of the gnome-king himself; the fact remains. Gold is in washed drift in Unst. The Shetlands are made up chiefly of crystalline Silurian rocks and Granite; the surface is ground down and glaciated, and strewed with glacial drift like other northern lands.

Those, then, who would find veins of auriferous quartz may seek with some hope of success in the high grounds of Sutherland,

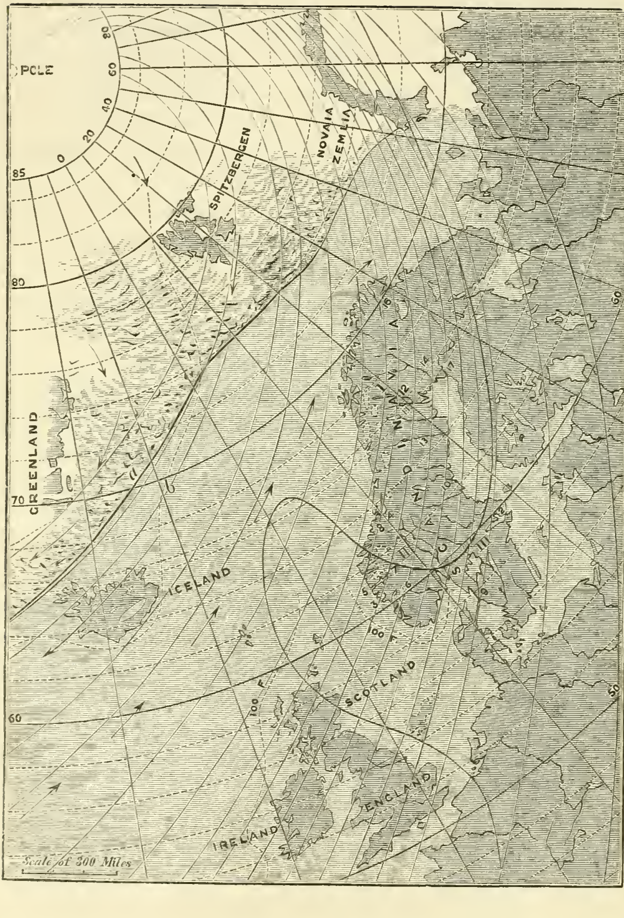
* ? Sedimentary rock.

and along all the river-beds, in rivers, rivulets, and rills; in stems, branches, and twigs; from delta to source; from root to bud. Those who are content to wash gold out of drift may seek for it in watercourses from Cornwall to Unst, and go thence to Russian Lappland. Gold has been found in Cornwall, in Wales, in Ireland, in the Lead Hills, in Argyleshire, in Ross-shire, in many places in Sutherland, in Shetland, in the river Tana beyond the North Cape of Europe. In one word, it has been found in drift along theoretical curves, which are facts at distant spots, and which were laid down to illustrate a glacial theory, which, together with facts out of which it was constructed, is more fully set forth in the work from which the following map is taken. (Page 30.)

Curves, which on this map pass over Scandinavia and the British Isles, repeat the south-westerly track made by great rafts of ice in the arctic current between Spitzbergen and Cape Farewell. The curves illustrate a theory which was built of facts, of which only some are recorded in the book whence the map was taken.

It must suffice here to state in explanation, that well-marked fresh south-westerly grooves have been copied from glaciated rock-surfaces at many distant spots which are out of reach of common glaciers, and that these grooves coincide with the curves.

Such grooves are on the top of Shanfolagh, which is a conical mountain on the west coast of Ireland, 2000 feet high. They are on lower hills on the east coast of Ireland, and at many intermediate spots. The graving-tools which made these marks were moved by some engine which was about 2000 feet deep at least. S.W. grooves are on hill tops near Snowdon, and aim along the sides of that range, so a vast engine passed there, and the tracks of it can be followed over England and Scotland. S.W. grooves are on the sides and tops of hills in Ceantire, and in Arran, on ridges between Loch Fyne and Loch Awe, on passes about the backbone of Scotland, on hills on the east coast, in East Lothian, Perthshire, Ross, and Sutherland; so graving-engines


POLE
GREENLAND
SPITZBERGEN
NOVAIA ZEMLIA
ICELAND
SCOTLAND
ENGLAND
IRELAND
SCANDINAVIA
Scale of 300 Miles

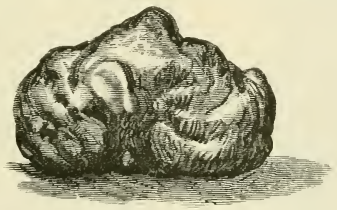
passed horizontally over the British Isles, 3000 feet above the present sea-level. On low rocks at Stavanger in Southern Norway, and at other stations along the whole Norwegian coast from Christiania to Wadsö, grooves aim at long firths, and can be followed from sea to watershed in every glen. These prove to demonstration that as Greenland is, so Scandinavia was. Raised sea-margins all round the peninsula prove that Scandinavia has risen, and it is still rising, from the sea.

At the mouth of the Trondhjem Fjord, and in West Fjord, beyond the arctic circle, S.W. grooves point along the coast and coincide with the curves on the map; as do certain grooves on the west coast of Scotland. On the backbone of Norway, on the Dovre, at 3400 feet above the sea; on the water-parting at the head of the Trondhjem Fjord, and at other high stations in Norway, grooves again coincide with the curves, and seem to prove that the engine which engraved all these curves on solid rocks came out of the arctic basin, and was an old arctic current more than 3000 feet deeper than the present sea.

The general conclusion arrived at is stated above, page 16; but much has still to be learned before the evidence is complete as to this suggested explanation for the origin of northern drift and Sutherland gold.

It is probable that gold and drift came from old silurian rocks, and from the watershed of Sutherland.

It is possible that the drift came from Scandinavia, or from the Polar Basin.



THE £9 NUGGET, NATURAL SIZE. (See page 21).

PROBABLE SOURCE OF THE GOLD.

Rock-Sculpture on a large scale on the West Coast of Sutherland and Cromarty, sketched from the Sea in 1848.

The foreground and lower hills are chiefly Laurentian gneiss ; the higher hills are chiefly Cambrian sandstones ; the passes between them are hollows carved out of the solid rock, and open out on the Silurian plateau, from which rivers flow north, east, and west to the sea. The shaded sky represents the probable depth of ice ; and of Cambrian sandstones destroyed and removed by "denudation" of some kind. The plateau is the probable source of the gold which has been found on the opposite sea coast in Helmsdale and Strath Brora.

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