STONAR AND THE WANTSUM CHANNEL.

PART I.—PHYSIOGRAPHICAL.

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STONAR is a small parish of irregular longitudinal shape containing 717 acres and lying between Ebbsfleet and Sandwich on the Sandwich—Ramsgate road. It has a written history going back to Saxon times and its existence in the period of the Roman occupation is sufficiently indicated. But the outstanding interest and importance of Stonar lie in its physical and geological record. In its stones and configuration, its closely confined encirclement and environment, are preserved the record of vast physical changes that occurred in the prehistoric period. The rise and fall of Stonar were not fortuitous. Its fortunes were moulded and determined by inexorable laws of cause and effect which had been in silent operation for thousands of years before the Christian era. If the effects, so far as Stonar is concerned, were local and mainly confined to the neighbouring chalk cliffs and the Wantsum Channel, the causes were of far wider extent.

For clearness and convenience the physical history of the Wantsum Channel may be summarized in the six propositions set out below. (See map.)

1. The Wantsum strait is a partly eroded channel in a shallow syncline of the Chalk which outcrops on both sides of it. In a portion of this depression between Minster and Ebbsfleet are the denuded remnants of the immediately later (Tertiary) formation known as Thanet Sand.[1]

[1] H. J. Osborne White, "The Geology of the country near Ramsgate and Dover." *Mem. Geol. Survey*, 1928, p. 45. A syncline may be defined as strata dipping towards a common line in a hollow depression.

VIEW OF THE NORTHERN END OF STONAR, WITH THE BUILDINGS OF THE SALT WORKS.
Engraving dated 1812.

2. The dominant currents formerly swept into the Channel through its northern entrance and piled up vast quantities of redeposited Thanet Sand and the newer Eocenes round its eastern exit.

3. The Thanet chalk cliffs formerly extended much farther seaward, and the flint shingle eroded from them was for a long time carried out to sea in a southerly direction. But the accumulation of fine materials round the eastern exit of the Channel formed a bank which arrested the dispersal of the flint shingle and caused it to deposit in a narrow line directly across the eastern mouth of the Channel.

4. Stonar as land surface did not exist in the early period. Its development as land was brought about by a combination of three factors operating successively: (*a*) The existence of Thanet Sand as a backing; (*b*) Accumulation against and on it of flint shingle from the Thanet cliffs; (*c*) Deposit of silt against the shingle. The relation of cause and effect existed between each of these stages and its successor.

5. The formation of Stonar was the principal factor in the silting up of the Wantsum Channel. The tidal currents were largely blocked, the sea channel disappeared, and there remained only the outflow of the two Stours over a part of its bed.

6. The next change to be noted did not develop out of local conditions but acted in opposition to them. Hitherto the North Sea had formed a bay opening into the Atlantic on its northern side, and the English Channel another bay opening into the Atlantic on its western side. These bays were separated by a chalk ridge which formed a land bridge between England and the Continent. Owing mainly to land subsidence this land bridge at a very early date was

breached by the sea, and the straits of Dover were opened. A huge volume of the tidal currents rushed along the English Channel from the Atlantic and poured into the North Sea from the south. The easterly drift began. The dominant tides now reached the east coast of Kent from the south, and shingle washed from the chalk cliffs of the South Foreland travelled along the coast in a northerly direction. The Goodwin Sands were formed: shingle was laid along the low coasts of Walmer and Deal and formed an outer fringe to the bank of Thanet Sand which lay beyond them.

The Continental Shelf.

The physical changes have extended over a wide area, but the area has a unity of its own. If we look at a physical map of Europe we see that the British Isles are the highest part of a great continental shelf. The surrounding seas are all shallow. St. George's Channel and the Irish Sea, the English Channel, the North Sea (including the Baltic) and a belt along the west coast of Ireland and the north coast of Scotland as far as the Shetland Isles, stand out in sharp contrast to the deeps of the Atlantic Ocean. In the North Sea the depth hardly ever exceeds fifty fathoms, and in places it is reduced to ten fathoms or less. On the other hand the Atlantic at a distance of fifty or sixty miles only from the Irish coast reaches a depth of over a thousand fathoms. See especially the physical maps of Europe and of the British Isles in Sir Cyril Fox's *Personality of Britain*, 3rd edition, 1938.

This continental shelf has been less stable than the continental land mass or the deep seas. A comparatively slight rise or fall of the shelf would increase or diminish the land surface. There is evidence that on more than one occasion Britain has been joined to the continent of Europe. The South Downs has its continuation and counterpart in the chalk hills of Artois in north-eastern France. It is also clear from raised beaches, old high river banks, submerged

forests and other indications that the changes have sometimes been of a local character and have not affected the whole of the shelf. But they have always taken place on some part of it.

The continental shelf would seem to have reached its greatest elevation in the Glacial ages and to have been followed by a long period of subsidence which only came to an end in the second millennium B.C. In the earlier period much of the North Sea was continuous land (see *Prehistoric England*, by Grahame Clark, p. 1). In the English Channel there was the land bridge at Dover, and Jersey was joined to the continent. (See *The Bailiwick of Jersey* by Jacquetta Hawkes and F. E. Zeuner, Ph.D., "The origin of the English Channel." *Discovery*, July, 1935.)

Numerous smaller changes not associated with any general rise or fall of the land have taken place. Many of these have been due to the movement of material by sea action from one place to another. The changes in the North Sea have to some extent differed in character from those in the English Channel, but in both the outline of the coasts has been altered. See the instructive section on changes of land within the Prehistoric Period in Southern Britain in Fox, op. cit., pp. 23-6, and especially Dr. F. J. North's map, Figure 10, on p. 25.

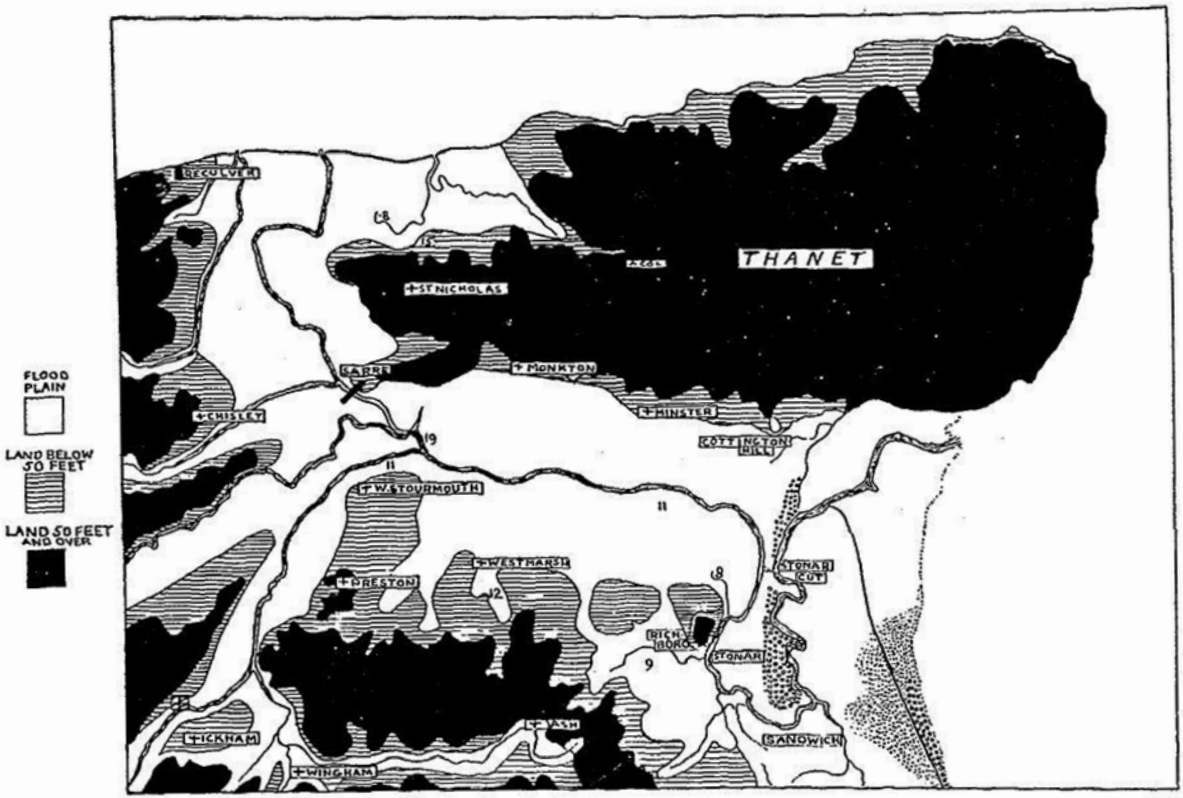
The North Sea.

The North Sea at the present day presents features which are consistent with its having been in past times an enclosed bay having an opening into the Atlantic on its northern side. The coast line of Holland and North Germany from the Scheldt to the Elbe, the Zuider Zee and the Frisian Islands, show exactly the low broken line of mixed land and sea, of sand and silt, that we should expect to find on a lee shore where the outflow of rivers mingles with the dying tides. The four great estuaries on the east coast of Britain all open out towards the north-east: Moray Firth, the Firth of Forth, the Wash (estuary of the Witham, Welland, Nen and Great Ouse) and the Thames and Medway estuary. The numerous submerged banks of fine deposits in the Thames

estuary are mostly elongated towards the north-east and lie along the coast line of Essex and Suffolk. Dunwich on the Suffolk coast has been washed away by the sea and its remains now perhaps exist in the mud banks lying along the coast. It was Domnoc in the time of Bede (*c.* A.D. 730) and at that time the seat of a bishopric. The North Sea is deepest at its northern opening and shallows considerably in its southern part especially south of the Dogger Bank. These facts point to a time when the dominant tides of the North Sea came from the north. But the clearest and most conclusive proof is found in the southward travel of the Stonar shingle.

The English Channel.

The evidence of tidal action in the Channel is stronger and more uniform. The movement is all in one direction. The eastward drift has carried everything before it. Old Winchelsea was swept away in 1287. Old Broomhill (Prumhel in *c.* 1165), a village on the borders of Kent and Sussex and a Liberty of Romney, has also disappeared. On the other hand there have been gains of land on and near the Kent coast. The ancient Cinque Port harbours of Hastings, Romney, Hythe, Dover and Sandwich have been choked up with shingle and silt. As early as A.D. 741 the mouth of the river Limene had been driven to the east as far as Romney (see King Eadbriht's charter of Romney of that date, B.C.S. 161, and King Offa's charter of Lydd in 774, B.C.S. 214), and it continued to advance in the same direction until it was halted by the cliffs of Hythe. Then in the great inundation of 1287 which destroyed Old Winchelsea the river broke back and has since (as the Rother) entered the sea at Rye. The great mass of shingle which forms the promontory of Dungeness has been formed and is still growing. The wide open river estuaries which form a conspicuous element in the North Sea are not found in the Channel. They have been smoothed out by the travel of shingle backed by the deposit of hill- and river-wash. The English Channel was at an early period an enclosed bay opening into the Atlantic on its western side and these



THE WANTSUM CHANNEL AS IT REMAINS TO-DAY.

changes have all occurred since the opening of the Straits of Dover enabled the tidal currents to sweep through into the North Sea.

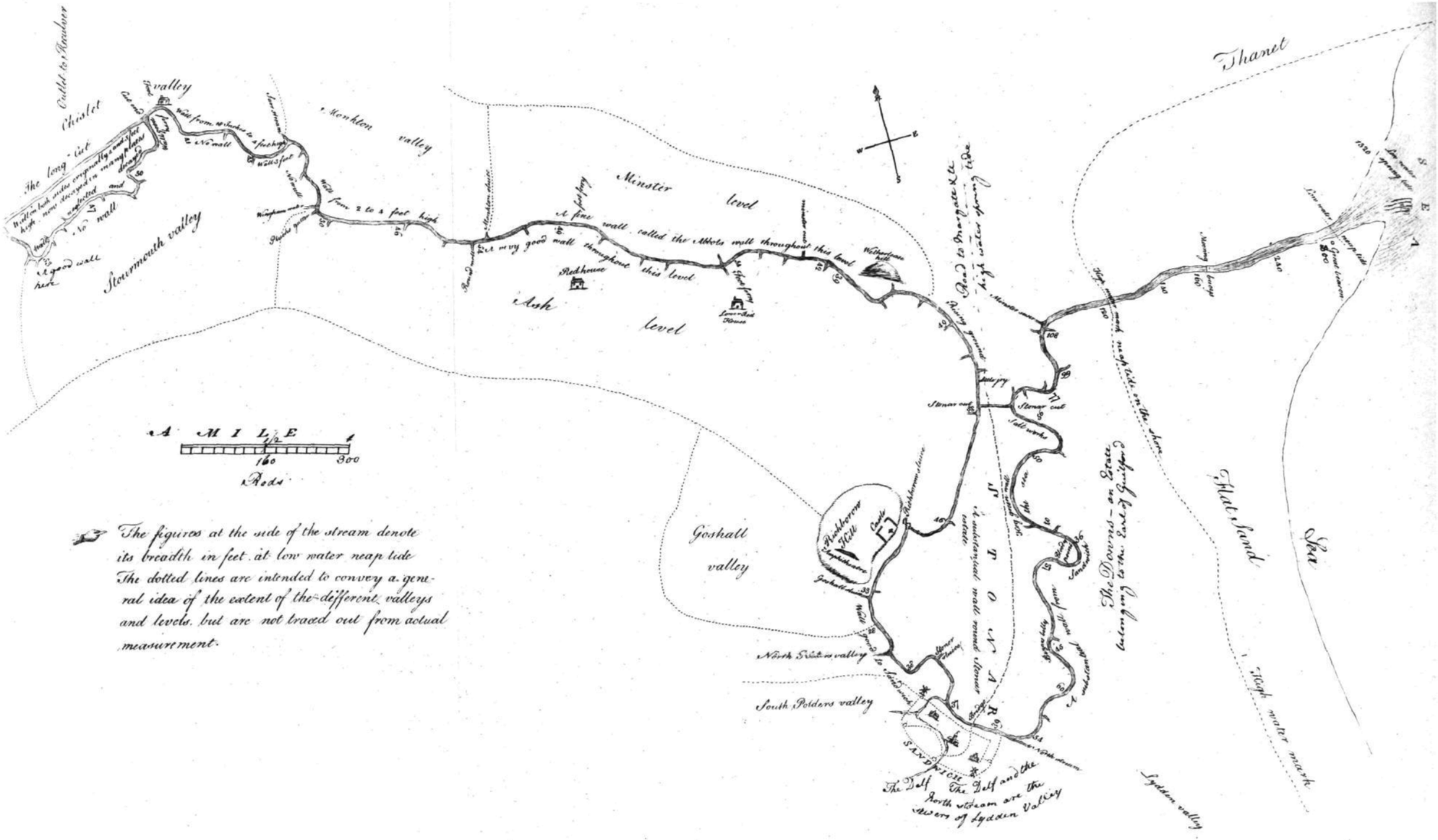
The Wantsum Channel.

Thanet is, or rather was, an island at the southern corner of the Thames estuary, and was known from a very early period. It is mentioned by Solinus (*c.* A.D. 280), Bede (*c.* 730), Asser (893), and frequently in the Saxon charters from 675. Asser says it was called Tenet in the Saxon tongue but Ruim by the British. From Monkton and Minster to the cliffs on the north and east sides it consists for the most part of an elevated chalk plateau, but along the Wantsum Channel on the west and south sides lies a stretch of low marsh land. The Thanet Sand of Minster extends eastwards as far as Cliffsend. It forms outliers in Weatherlease Hill and Richborough and a little farther to the east the denuded remnants are exposed in a long spur to a point on the Sandwich—Ramsgate road south of Halfway House and opposite Pepperness. The British name of Thanet, Ruim, seems to mean marsh and to imply that the side adjoining the mainland of Kent was best known to the early inhabitants.

Thanet was separated from Kent by the Wantsum sea channel. The latter is first mentioned by Bede who says:

> "On the east of Kent is the large isle of Thanet containing according to the English way of reckoning six hundred families, divided from the other land by the river Wantsum which is about three furlongs over and fordable only in two places for both ends of it run into the sea."

Into the Wantsum were discharged the waters of the river Stour which drained a large area of East Kent and opened out into a tidal estuary at Fordwich before reaching the Wantsum at Stourmouth. The Little Stour also reached the Wantsum at Stourmouth, and various smaller streams drained into the sea channel at other places. The streams were flat and sluggish with much silt brought down as hill-wash but the channel was scoured by the tides.



WM. BOYS' MAP OF THE STOUR IN 1775 (portion).

It is obvious that great changes have taken place in the Wantsum since Bede wrote twelve hundred years ago. It was then a sea channel of moderate width (three furlongs is 660 yards or three-eighths of a mile). But to-day the Wantsum has become a mere name. The northern arm has shrunk into a system of dykes and marsh and in the eastern arm the two Stours wander in a united stream with a width of about fifty feet over a part of the ancient channel bed. The Wantsum Channel has disappeared and Thanet has ceased to be an island.

The state of the Wantsum in Bede's day was very far from being its original condition. Changes had been taking place for countless centuries before he wrote and were still in operation in his time. It is possible to estimate with moderate accuracy from ordnance survey levels and excavation the width and depth of the channel before the changes which have transformed it began to operate. In 1775 William Boys the historian of Sandwich prepared the case of Sandwich against a Bill introduced into Parliament to enable the Commissioners of Sewers to make the Stonar Cut. The case contains valuable information and says on page 5 :

> " The River Stour from Fordwich Bridge to the sea runs in a narrow Channel and winding Course through a marshy Plain about one mile and an half broad at a Medium there called the Levels or Valleys or Meadows indifferently. In a straight line it is about twelve Miles long and in its winding Course about twenty-one Miles. The Valleys are bounded on the North and South sides by rising ground that extends nearly to the Sea. A little below Weatherlease Hill in Minster Level the River takes a sudden turn towards the South for about three Miles as far as the Town of Sandwich and there turning Northward forms the land of Stonar into a Peninsula : the Isthmus or Neck near the Saltwork being little more than 250 yards broad."

The " marshy plain " of Boys through which the Stour runs is not entirely the same thing as the old Wantsum Channel. It includes from three to four miles of the Stour estuary between Fordwich and Stourmouth, and does not include the northern arm of the channel. The valley of the

channel is definitely wider than the valley of the river estuary. The sudden turn to the south of the river for about three miles from a little below Weatherlease Hill to Sandwich which is noted by Boys cuts directly across the old bed of the channel and proves the breadth of the eastern entrance. A careful estimate based on the O.S. Levels leads to the belief that the original average breadth of the Wantsum Channel was about two miles, and this estimate is not inconsistent with the observation of Boys in 1775. The breadth was not uniform and was determined by the rising ground on each side. At both ends the channel opened out rather widely over the low ground of the coasts.

Information as to the original depth of the Wantsum Channel has been obtained from excavation. On the evidence of borings undertaken by Messrs. Pearson and Dorman Long the Stonar shingle bank is found to rest on an uneven bed of hard sand which varies in depth from the surface up to forty feet. The shingle which has been, and is still being, worked for the flint gravel, consists of well-rolled flint of all sizes with sand, and with a very small proportion of unrolled flints. Included are a few rolled flat and oval pieces of the indurated lime-cemented sandstone which occurs as doggers in the Thanet Sand at Cliffsend, cemented chalk breccia, and pounded fragments and pebbles of the tabular flint which may be seen at the much denuded junction of the Chalk and the Thanet Sand in Pegwell Bay. Erratics of quartz and of igneous and altered rocks also occur rarely, and go back to the *Pleistocene*. The problems opened up by the occurrence of these far travelled erratics will be discussed later.

In 1922-3 the Southern Railway replaced the swing bridge across the Stour near Weatherlease Hill by a fixed bridge. The contractors informed us that they had had great trouble to find a firm foundation. They expected from borings put down some years previously to find clay at thirty feet or so but none was found. The upper layer was silt, but at between twenty and thirty feet down they came on a bed of sand containing shells which they believed to be marine, and only at about forty feet on a hard layer of sand.

This was doubtless the Thanet Sand which contains hard layers due to lime from masses of largely comminuted shells.

This evidence seems to justify the assumption that the original depth of the Wantsum Channel was about forty feet. The scour of the tides would tend to maintain this depth at a more or less uniform level.

We can now form a mental picture of the Wantsum Channel as it was in early days before the changes which resulted in its destruction had begun to operate. We conceive it as a natural arc-shaped stream of tidal water cutting off Thanet from the mainland with a breadth of about two miles and a depth of about forty feet and with wide open ends. It formed a safe roadstead for ships and a sheltered line of communication with the Thames. It provided here the protection that was afterwards afforded by the Goodwin Sands to the roadstead of The Downs. But its days were numbered, and the causes of its destruction must now be considered.

The Denudation of the Thanet Sand and Superincumbent Beds.

The dominant tidal currents of the Wantsum Channel formerly swept in through the northern entrance and discharged through the eastern exit. This would naturally follow when the North Sea was an enclosed bay with an opening on its northern side. The northern entrance of the Wantsum is in the mouth of the Thames estuary and was the meeting place of the Atlantic currents and the outflow of two considerable rivers. The submerged sandbanks near this entrance indicate much disturbance with considerable deposit here. But the overwhelming proof that the currents came from the north is found in the extensive deposits which have transformed the coast line round the eastern exit, created the conditions which started the drift of the Thanet shingle to Stonar and formed the Lydden Valley.

One of the earliest effects of the northerly currents in the Wantsum was to carry down huge quantities of the Thanet Sand from the neighbourhood of Minster and to

re-deposit them round the eastern exit. There is a noticeable difference between the two ends of the channel. At the northern end the coast line has changed but little and lies evenly between Reculver and Birchington. But at the eastern end the coast line has been completely changed and the change is mainly due to the travel of the unconsolidated sands.

The old coast line at the eastern mouth can be traced by the higher ground and took the shape of a wide open bay extending from Cliffsend to Walmer. The hollow between Walmer and Deal and on to Sholden (Blunt's Brickfield) has been filled up by hill- and rain-wash (brickearth), while seaward the rest of the bay has been filled up with alluvium, but it is still known as Sandwich Bay. On the Thanet side the higher land runs from Minster to Cliffsend. The southern corner of the channel at this end is marked by the outlier of Richborough of Thanet Sand capped by Woolwich Beds, and the higher land of the old coast line of the bay continues from Richborough with some interruptions round Sandwich, past Worth and on to Northbourne, Sholden and Deal. Between Richborough and Sandwich lie the Goshall marshes and The Poulders. Another break in the old coast line was between Worth and Northbourne where two streams from the upland entered the bay. The smaller stream came from Eastry; the larger one called the North Stream began as a drainage hollow near Whitfield and was continued through Sutton and Northbourne (where it received an affluent both called the Northbourne brooks) and joined the Eastry stream near Foulmead and there emptied into the sea.

The North Stream was fenced off from the sea by a ridge of Chalk, which is cut through at Foulmead, and now continues its course in the Lydden Valley past Worth and Sandwich and discharges into the lower reach of the Stour on the sea side of Stonar. On the eastern side of the Lydden Valley is a stretch of blown sand which extends in a long strip about half a mile in width from a point opposite Richborough to Sandown Castle, a length of about four miles. This æolian material is known for the greater part of its length as the Sand Hills and near Deal as the Tenant Hills. It is dry and

well drained and unrivalled for the game of golf. Three well-known golf courses lie end to end along its length. Thanet Sand was probably its parent. Comminuted flint enters very little into the constitution of the sand, but for this there is a physical and chemical explanation.[1]

On the outer (seaward) side of the Sand Hills and distinct from them lies a narrow belt of shingle, and this is obviously the well-known eastward drift coming from the south. It forms no part of the Lydden Valley.

There has always been a difficulty in seeing how the deposit of shingle at Stonar could have started. It lies in what was practically the open sea and must have been washed away and swallowed up by the sea unless it had some backing. This backing was constituted by the re-deposited remnants of the Thanet Sand which had been carried down the Wantsum Channel. The sand is found *in situ* under the Stonar shingle. With the latter there is much coarse sand. Its constituents await study. The sand also formed an outer bank against which the shingle could rest and at a later stage it was re-sorted and piled up as the Sand Hills. The sea could not act on it as on the coarser shingle. Owing to its finer texture it was quickly deposited and formed into banks which the waves rolled over but could not displace. The firmness of wet sand as opposed to the ease with which shingle is moved by the waves is a matter of everyday observation.[2]

The Stonar Shingle.

The Stonar shingle came from the north side. It had its origin in the flint nodules washed by erosion out of the chalk cliffs to seaward of the North Foreland, of Ramsgate and Pegwell and from old land surfaces. It contains huge rolled flints which cannot have travelled very far, and

[1] For the evidence of flint in the Thanets see M. I. Gardiner—"The Greensand Bed at the Base of the Thanet Sand." *Q. J. Geol. Soc.*, XLIV (1888), pp. 755-60, and P. G. H. Boswell, *Q. J. Geol. Soc.*, LXXI (1915), pp. 536 ff.

[2] A valuable study on this subject, with a discussion, is to be found in H. M. Marsh's paper, "The Alongshore Drifting of Beach Material." *Proc. Geologists' Association*, Vol. XXXVI (1925), pp. 434-48.

much small shingle. Its northern origin has been recognized by geologists for more than half a century. In an unpublished lecture by the late George Dowker at Deal in 1885 on the recession of the sea at Sandwich (the MS. of which is in our possession) he said :

> " The beach of Stonar extends to Cliffsend : it is eight hundred feet wide at Stonar and gradually tapers off towards Pegwell. It differs materially from the beaches at Deal and Walmer. The stones comprising the beach at Deal and Sandown are all derived from the chalk at Dover and St. Margarets. When the sandhills were formed there was no beach here. Stonar beach is mainly derived from the cliffs of Pegwell and Ramsgate (Dowker's note : ' Topley and Whitaker confirm this '). When Stonar beach was formed it travelled from north to south, exactly opposite to the present direction. This must have been caused by a different set of tides. An old deposit of mud with littoral shells shows that a bay which existed here in times past was silted up, and this was probably by the shifting of the sea currents. The formation of the beach was the probable cause of deviation of the Wantsum from the straight line."

A somewhat similar view is expressed by Mr. H. J. Osborne White in " The Geology of the Country near Ramsgate and Dover " (*Mem. Geol. Survey*, 1928, p. 71). Strong corroboration is afforded by the numerous traces of Thanet Sand found in and below the Stonar shingle by the borings. Stonar is in fact an extension of the coast of Thanet. It was formed at a time when the North Sea was an enclosed bay open to the Atlantic on its northern side and the dominant tides came in from the north.

The boreholes of Messrs. Pearson and Dorman Long at Stonar were put down over the whole area from which it was expected that payable depths of shingle could be dug or dredged. The results of these borings are important and of great interest.

(1) North of Stonar Cut the shingle was only from 9″ to 4′ 6″ thick and had comminuted shell mixed with it.

(2) In the central part where Stonar attains its greatest breadth the shingle was found to a depth of 40′, resting on the grey quartzose and felspathic sand of the Thanet beds. Practically the whole of this shingle lies on the east side of the Sandwich—Ramsgate road. On the west side borehole No. 20 in Kitchener Camp showed sandy ballast below grey sand to 15′, and No. 19 to the south showed dirty ballast and brown clay down to 18′. No other holes on this side showed ballast.

(3) To the south of Stonar House the boreholes showed only silt and sand.

The northern borings seem to indicate that much denudation of the original shingle had taken place, and that the shingle here was of a much later age than the main bank to the south. From this it seems to follow that for a long time after the drift of shingle had begun the northern entrance of the channel at Ebbsfleet remained open and that much of the drift was washed away by tidal action.

The peculiar shape of Stonar as we know it with the sharp turn of its surrounding river to the south from Ebbsfleet to Sandwich and its equally sharp turn to the north from Sandwich back to Ebbsfleet is due in the first instance to the deposit of Thanet Sand, and only secondarily to the Thanet shingle which was laid down as and when the sandy foundation permitted. The wearing away of the Thanet cliffs and the re-deposit of sand round the eastern exit of the Wantsum Channel had proceeded together until the bank sufficed to hold up the shingle, and Stonar as land surface began to come into being. Entrances at both the northerly and southerly ends of the eastern mouth were kept open for a time by the tidal currents but the growth of the sand bank at length closed the northern entrance and enabled the Thanet shingle to reach Stonar more freely. A gradually increasing part of the shingle drift succeeded in getting across the northern channel and the main deposit came to rest nearly opposite Richborough in the central part of Stonar. In this

condition the tidal currents at both ends of the obstruction would increase for a time, and the main part of the hill-wash and silt would be deposited in the slack water on the west side of the shingle.

The southern entrance of the channel at Sandwich has always remained open though greatly narrowed by the recent deposits. Perhaps this was not entirely due to tidal action and the outflow of the rivers. It may well have been that the shingle had not reached the limit of its southerly travel when the dominant tides were reversed by the opening of the Straits of Dover.

The Stonar shingle could not by any possibility have travelled from the south and cannot be due to the eastward drift. The nearest chalk cliffs to the south are at Walmer, more than six miles away. The flints from these cliffs are found as shingle along the shores of Walmer and Deal, and the material gradually peters out as Sandwich Bay is reached.

The sharp turn of the Stour to the north from Sandwich was not caused by the eastward drift as is often believed. The Stour waters had to find an outlet when they came against higher ground at Sandwich and they passed along the slight hollow between Stonar and the bank of Thanet Sand lying outside it. This passage for the Stour was practically a continuation of the Lydden Valley and was only one of the many parallel valleys which fall towards the Wantsum.

The Stonar shingle is of all sizes both large and small. Many tons of the flints from it were used at Richborough in the masonry foundation of the late first century, and the great late third century wall is mainly built of flint boulders characteristic of the Stonar shingle. (*Official Guide to Richborough Castle*, 1933, pp. 14, 22.)

The Ebbsfleet Entrance.

The evidence of extensive denudation of shingle in the northern part of Stonar can only mean that for a long time an entrance to the Wantsum Channel was maintained at Ebbsfleet. It is indeed probable that at one time this was the principal entrance to the channel and so remained as long

as the scour of the tides sufficed to keep it clear. Ebbsfleet is the traditional landing-place of St. Augustine and his followers in A.D. 597. The remarkable course of the Stour in the bed of the channel appears to indicate that the river originally found its outlet to the sea through the northern mouth at Ebbsfleet, and that as this mouth was gradually choked up the river water was deflected in a southerly direction to the Sandwich exit. This was obviously the view of the late George Dowker (see quotation above). There is evidence that in the eleventh century the shingle drift was giving trouble. In the reign of King Harold it is recorded of an abbot of St. Augustine :

> " Then the abbot Aelfstan set to work with a great aid and caused to be dug at Hyppeles fleote a great delve, and intended that a ship current (i.e. of voyaging size) should lie therein." (Kemble, C. D., 758 ; Thorpe, Dip. Ang., p. 338.)

Stonar had belonged to St. Augustine's from a time prior to the reign of Canute, and it was of importance to the monks to maintain their entrance at Ebbsfleet so as to avoid the dues and restrictions imposed by their jealous neighbours of Christ Church who controlled the Sandwich entrance. The hostile relations between the two monasteries seem to appear in 1266 when the abbot's water mills (at Stonar) and Ebbsfleet were burnt by the men of the town and of Sandwich (Thorne's *Chronicle*, tr. Davis, p. 249).

There was a mill at " Hippilisflete " in the closing years of the thirteenth century (*Black Book of St. Augustine*, 54) and one or more at Stonar (*ibid.*, 18, 21). The Sandwich records of 1365 state that in this year there was a great inundation and that the town of Stonar was almost destroyed.

The water mills at Ebbsfleet and Stonar must have been tide mills and they were probably placed on opposite sides of the northern entrance. It is recorded in Domesday Book that a mill of this character existed in 1086 at the mouth of Dover estuary.

The surface level at Ebbsfleet on the Sandwich—Ramsgate road is as low as 10′ 3″ above Ordnance Datum,

while to the north and south of it on this road the spot-heights are respectively 17′ 3″ and 14′ 2″ above Ordnance Datum. The abbot's wall shown on the 6″ Ordnance Sheet XXXVII S.E. runs along the north side of the Stour and turns away from the river to the Sandwich—Ramsgate road nearly opposite to the small fleet in the *lower course* of the river, thus cutting off the drainage system of Ebbsfleet from Stonar. The dyke system of Ebbsfleet at the present day converges on this little fleet and shows that it is still a separate drainage area.

This evidence clearly establishes the existence at an early date of a northern entrance to the channel at Ebbsfleet and of its gradual choking up by the travel of sands and of shingle from the Thanet cliffs.

Chronology.

The dates of the changes which led to the formation of Stonar and to the various modifications of it are not without difficulty, and inquiry into them must be to some extent speculative.

In Pleistocene times the district round Stonar was not a coast but a land surface surrounded by other land including the land bridge to the continent and the southern area of the North Sea. The continental shelf then seems to have reached its greatest elevation and to have remained high for many millenia. During the Mesolithic and Neolithic periods, however, the conditions had begun to alter. Sir Cyril Fox (op. cit., 47) has drawn up a schematic chronology of Britain, mainly grounded on climate, during the seven millennia following the last glacial period. He begins with the "Boreal" phase (*c.* 7000-5000 B.C.) which was dry and warm. It was followed by the "Atlantic" phase (*c.* 5000-2000 B.C.) with moist and cool climate. The latter climatic changes were marked by a notable growth of great forests, at first hazel and then mixed oak (oak with elm and lime). But they were also marked by a general subsidence of the great continental shelf, relative perhaps to a rising sea-level, due no doubt in part to the disappearance of glacial conditions and to the amelioration of the climate. At the

beginning of the "Boreal" phase the "greater part of England stood fully 70 feet above its present level, for the oldest deposit . . . is a land surface . . . 60 feet below tide level" (Clement Reid, *Submerged Forests*, p. 120). It was during the "Atlantic" phase and about 5000 B.C. that the final land connection with the continent was severed. The "Sub-Boreal" phase followed (*c.* 2000-700 B.C.) and was again dry and warm. It was during this phase and perhaps about 1600 B.C. that the relative subsidence is believed to have ended. In the words of Clement Reid (op. cit., p. 116) "About 3,500 years ago we get back to the period of unchanging sea level in which we are still living."

If we accept the general statements that subsidence had been going on in Britain for a period of 5,000 years or more, that the present levels were reached 3,500 years ago, and that a land bridge to the continent has not existed for nearly 7,000 years, it is not to be concluded that the conditions round Stonar had at these early dates taken the shape found in the historic period. The enormous periods of the changes according to Fox's chronology indicate that they were very slow and gradual in their operation. The subsidence produced new conditions which called for innumerable local adjustments and these also extended over a long period. The historical references given above show that these local adjustments were continuing in the Saxon period, that they were still going on for centuries after the Conquest and that they have not entirely ceased at the present day. During the last century marked alterations of the east coast line have taken place at Kingsdown, Sandown Castle and other places.

It has been mentioned that erratics of igneous rock have been found in small quantity in the Stonar shingle. These are the oldest material there and must have been transported from a considerable distance but we can know little of the conditions under which this presumably glacial drift reached the area. We are perhaps entitled to assume that the Wantsum Channel and the coast line round its eastern entrance did not begin to take the shape found in the historic period until subsidence had reached its lowest

level in the second millennium B.C. By the sea route Stonar lies some fourteen or fifteen miles to the north of Dover and is protected from the south by the bulging cliffs of the South Foreland. The Straits of Dover are shallow and in places the depth of water is as little as ten fathoms or less at the present day. See the physical map of Southern Britain in Fox, op. cit., p. 94. When the Straits were breached the eastward drift would not at first have great strength. The main current would be deflected from the coast line by the projecting cliffs of the South Foreland and the first effect on the North Sea would perhaps be the piled up material of the Goodwin Sands.

The Wantsum Channel seems to have remained open to the end of the Roman occupation and two hundred years later Bede could still describe it as of the width of 660 yards. But it had then shrunk to less than one-third of its original size, and four hundred years later the evidence of abbot Aelfstan seems to show that the Wantsum had ceased to be a sea channel, and that its eastern entrance at Stonar was limited to two passages for the Stour water and the tidal currents.

The physical and geological history of Stonar and the Wantsum Channel thus take us back to the Glacial period. Much of what happened in the earlier millennia is hidden from us, but enough is known to show that the development of this region of our county is of exceptional importance and interest. For valuable help in the preparation of this paper and for access to workings the authors must thank Messrs. Pearson and Dorman Long, Ltd., and their Manager Mr. L. S. Layman. For critical suggestions thanks must also be tendered to Mr. K. P. Oakley, Ph.D., F.G.S., of the British Museum (N.H.).