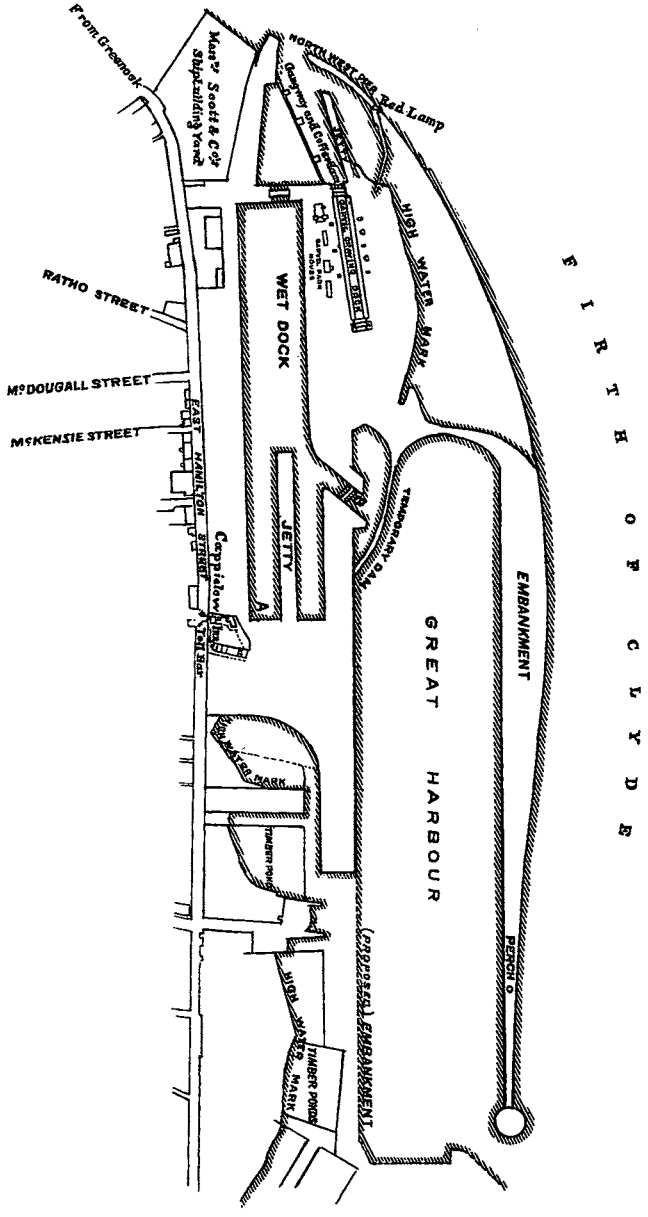
No. XXXI.—Notes on the Occurrence of *Leda Arctica* (Gray); *Lyonsia Arenosa* (Möller), and other Organic Remains, in the Post-pliocene Clays of Garvel Park, Greenock. By Thomas Scott and James Steel. [With a Plan, Plate X.]

[Read April 12th, 1883.]

During the extensive excavations made in the course of forming the James Watt Wet-Dock at Garvel Park, Greenock, fine sections of Post-pliocene clays have been exposed. These clays and their contents have been already very fully described, and we should not have cared to add anything to what has been so well said by Mr. David Robertson, had we not, during an extended examination of part of the same deposits, secured a number of organic remains, which Dr. J. Gwyn Jeffreys, to whom we submitted some of them, says "are peculiarly arctic, and therefore more interesting than the usual shells of the Clyde beds." As they decidedly differ from those previously described from Garvel Park, the following notes may not be without some interest.

We visited Garvel Park about the middle of July last (1882)—not having been there for some time previously—and noticed a deep section of clay exposed in the south-east branch of the dock (marked A on plan). This clay we found had been deposited in an abrupt and deep depression of the sandstone rock, which, reaching the surface a little to the west and north, dipped rapidly south-eastwards, till a depth of fully 40 feet was reached. This depth continued but a short distance, when an almost perpendicular face of rock rising nearly to the surface was met with, appearing to indicate a rather extensive fault. The clay which filled this hollow seemed to be made up of three or rather four separate beds. Immediately above the sandstone rock was the usual non- or almost non-fossiliferous laminated clay. Next was what we have taken the liberty to call the "Pecten and Cyprina bed,' consisting of tough hard clay of a dark-reddish colour, and containing boulders of various sizes, and which was in many places so crowded with *Pecten Islandicus* and *Cyprina Islandica* that they formed a distinct and well defined layer, while in other places these shells were more scattered through the bed. These two beds would be together from two to three feet thick, the thickness varying somewhat. Next was a mass of clay, generally



PLAN OF GARVEL PARK DOCKS, GREENOCK.

M^cFarlane & Erskine, Lith^rs Edin^r

with more sand in its composition than the other clays, some of it being rather tough, and almost black from the great quantity of organic matter (chiefly vegetable), mixed up with it, some of it very firm and of a dark-reddish colour, containing in places the elliptic variety of *Astarte sulcata* in great abundance, while in others it was nearly pure sand. Above all was from twelve to eighteen inches of a sandy deposit, evidently belonging to more recent times.

In the clay extending from the "Pecten and Cyprina bed" up to the recent deposit were found the various organisms to which we wish to draw your attention; but before doing this it may be as well to explain that a short time after examining the section at the south-east cutting we visited the north-east branch (marked B on plan), where also we found a section of clay which, though not so deep as the other, was yet very similar in composition, and contained the same fossils. As we found that the remains here were on the whole more plentiful and in finer condition than in the other portion, we afterwards confined our attention to it.

As already stated, in the extensive deposit overlying the "Pecten and Cyprina bed" we found a number of shells belonging to a decidedly arctic type, as indicated by the following species:—

1. *Leda arctica* (Gray)—Syn. *Nucula arctica, Portlandica arctica.* Distribution—circumpolar in the North Atlantic and Pacific, Novaya Zembla, Jenissei Bay, Iceland and Finmark, 5·1333 fathoms. Common all through the clay-bed here referred to.

2. *Astarte borealis* (Chemn.). Common all through the bed. Many specimens of larger size and in fine condition.

3. *Lyonsia arenosa* (Möll.). Found in the more sandy parts of the deposit, but not very common. Distribution—Greenland, and Davis' Straits. We cannot find any former records of its occurrence as a fossil in Britain.

4. *Nucula tenuis*, var. *inflata* (Morch.). Common, and in fine preservation. Distribution—Greenland and Davis' Straits.

5. *Modiolaria lævigata* (Gray). Its abundance in some places was remarkable. It was so plentiful that the clay could not be dug without crushing some. Parts of the clay where they occurred were black from the quantity of organic matter mixed through it, and the shells were so easily crushed that it was difficult to get whole specimens. Distribution—Greenland, Davis' Straits, Novaya Zembla.

6. *Dacrydium vitreum* (Torell). This pretty little bivalve was not very common, though frequent in one or two places.

7. *Thracia truncata* (Brown). Not common, especially full grown specimens, the young and half grown being more frequent.
8. *Buccinum Grœnlandicum* (Chemn.). Not common.

Besides those shells above mentioned we found a number of others and also some ostracoda and foraminifera, some of which we had not before found in Garvel Park. These and some other things from the same deposit are included in the list at the end of this paper.

We noticed that *Pecten Islandicus*, though plentiful in the clay below, was here rare and fragmentary, and the same may be said of *Cyprina Islandica*, except that a whole valve was sometimes found, but *Tellina calcaria* was frequent and of a heavier build than we used to find it elsewhere.

It will be noticed, then, that here we meet with a group of marine fauna decidedly different from, and of a more arctic type than has been found previously in Garvel Park, and that it is confined to a comparatively limited area. The presence of such shells, and especially of *Leda arctica*, would seem, on the authority of Sir Charles Lyell,* to indicate the recurrence of a period of greater cold than that existing during the deposition of the usual shell-bearing clays of the Clyde valley.

We are not satisfied, however, that such is the case with regard to this deposit, for we have noticed no apparent break in these shell clays; the beds appear to be continuous, though the fauna differs. From a frequent examination during the last six or eight months of the section in the northeast branch, we have been able to a great extent to make out that the beds here, though varying a little in the material of which they are composed, and in their relative thickness, are a continuance of the same beds found further west. Knowing that a difference in the material, as well as in the depth of the sea-bottom, is sufficient to account for a difference in the kind of organisms living upon it, we are inclined in the meantime to think that the presence here of the remains referred to, though differing so much as a group from those formerly noticed, may be ascribed to changes such as we have indicated, rather than to the recurrence of a period of more extreme cold. But, possibly, as the excavation of the dock proceeds, the reasons for this difference in the organic remains may be more clearly traced.

* Students' Elements of Geology, 3rd ed., pp. 156–187.

In concluding this paper we wish to acknowledge our obligations to Dr. J. Gwyn Jeffreys, F.R.S., and Mr. David Robertson, F.L.S., for great and uniform kindness in naming the specimens submitted to them, which has been a great encouragement in our investigations. We have also to thank Mr. Kerr, the manager, and Mr. Peter Scott, the inspector of works, at Garvel Park, for kind assistance in various ways.

A List of Shells and other Organic Remains found in the Post-pliocene Clays at that part of Garvel Park, Greenock, referred to in the preceding remarks.

PLANTÆ.

Algæ—various species,	abundant in some places.
Musci—various species,	common.
Chara, sp. (?),	not very uncommon.
Leaves of plants, apparently ericaceous,	common and very perfect, but fragile.

FORAMINIFERA.

Cornuspira (D'Orb.),	
foliacea (Phil.),	common.
Lagena (Walker),	
gracillima (Seg.), smooth form,	not uncommon in some places.
Marginata (Mont.),	
var. *Orbignyana*,	rare.
var. (?)	rare.
ornata (Will.),	not uncommon, but easily overlooked.
hexagona (Will.),	not uncommon in the more sandy clay.
caudata (D'Orb.),	frequent; fine specimens.
Dentilina (D'Orb.),	
sp (?)	rare.
Cristellaria (Lamarck),	
crepidula (F. and M.),	rare.
polymorphina (D'Orb.),	
acuminata (Will.),	common.
Globigerina (D'Orb.),	
bulloides (D'Orb.),	frequent.
Discorbina (Parker and Jones),	
Wrightii (Brady),	not common.

Starfish remains (not yet determined).

ANNELIDA.

Spirorbis (?) *Wattianus* (Scott).

CRUSTACEA.

OSTRACODA.

Cytheropteron (G. O. Sars),	
arcuatum (B., C., and R.),	locally frequent.
inflatum (Brady),	frequent.
Cytheridea (Bosquet),	
Sorbyana (Jones),	common.

CIRRIPEDIA.

Balanus (Lister), *porcatus* (Da Costa), var. *elongata* (?),	common.

MOLLUSCA.

CONCHIFERA.

Modiolaria lævigata (Gray),	remarkably abundant, but very fragile.
Dacrydium vitreum (Torell),	frequent in some places.
Nucula tenuis (Mont.),	
var. *inflata* (Mörch),	common.
var. *sulcata* (?),	rare.
Leda arctica (Gray),	frequent.
Axinopsis orbiculata (G. O. Sars),	frequent.
Astarte borealis (Chemn.),	frequent.
crebricostata (Forbes),	frequent.
Thracia truncata (Brown),	not common.
Lyonsia arenosa (Möll.),	not very common.
Saxicara rugosa (Linné),	
var. *pholadis* (Jeffreys),	rare.
Neæra subtorta (G. O. Sars),	rare.

GASTEROPODA.

Trochus umbilicalis (Brod. and Sow.),	common, especially in the more sandy clay.
Natica affinis (Gmelin),	some specimens very large; some even with the operculum.
Velutina undata (Smith),	rare.
Buccinum Grœnlandicum (Chemn.),	not very common.
Fusus Barvicensis (Johnst.) (?),	one specimen.
Bulla utriculus (Brocchi),	not unfrequent.
Utriculus obtusus (Mont.),	
var. *turrita* (Möll.),	of frequent occurrence.
Philine scabra (Müll.),	rare.
lima (Brown),	rare.
aperta (Linné),	rare—found in the upper sandy bed near Garvel House.

Some of the above have not before been recorded from Garvel Park, while others, though frequent in the clays here referred to, were rarer further to the west.