XL. The Limestones of Aberlady, Dunbar, and St Monans.

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THE limestones of the coast sections of Aberlady Bay and Dunbar, and those of the opposite shore at St Monans in Fife, have long been known to occupy the same horizon beneath the Edge coals and above the Calciferous Sandstones of the Lower Carboniferous Series. In the Survey Memoir on the Geology of East Lothian, published in 1866, Mr Howell attempted to correlate certain of the limestones seen in the Aberlady section with certain limestones at Dunbar, which had been previously mapped by Sir A. C. Ramsay. Three limestones are there given in the section for Aberlady Point: the lowest or white limestone resting on the Calciferous Sandstone; the second, ten feet thick, with a seam of coal beneath it; and the third, six feet thick, separated from the second by sandstone and shale. For the Dunbar section there are five limestones given, of which the middle one is termed the Skateraw Limestone or Main Bed, and is underlain by a thin seam of coal. This limestone with its seam of coal is taken to be the second limestone in the Aberlady section, under which also a seam of coal is mentioned. That this correlation is incorrect will be seen when we come to compare the sections in these two regions as drawn up during the late re-survey of this area. In the Appendix to the same Memoir Mr Salter states: "It is certainly a fact that the five or six beds of limestone on the opposite Fife coast, distant nineteen or twenty miles, are nearly identical in fossils with the Dunbar series." "We have been too much in the habit of treating the mountain limestone as a whole. Its separation into distinct beds over part of the Scottish area has shown that it is possible with careful collecting to identify these distinct layers—a point of some importance in the search for coal." This prediction of Mr Salter's of the establishment of palæontological zones amongst these lower limestones has, however, yet to be confirmed.

In the re-mapping of the Dunbar and Aberlady districts by Mr Clough and myself, combined with traverses along the Fife coast by members of the Survey staff, it has nevertheless been found possible to correlate certain of the limestones in the three districts owing to a remarkable coincidence in the

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sequence and character of the four lowest limestones. These have each a peculiar character, that is easily recognised, and which may be looked upon as petrographical, or due to the different conditions under which they were formed. They may be seen in the three sections in the same sequence and with very little variation in the accompanying sediments. I will first describe the general character of these four limestones, and afterwards show vertical sections of the beds at Aberlady, St Monans, and Dunbar for comparison.

The lowest limestone is essentially a coral reef and is probably well known to most present. It is very pale, almost white, owing to the great masses of *Lithostrotion junceum* and *Lithostrotion irregulare* of which it is almost entirely built up. These corals are evidently in position of growth, though bent and distorted by the weight of formerly overlying beds. There is a large marine fauna associated with these corals, as is so generally the case with coral reefs at the present day. Certain layers in the limestone and masses lying in hollows on the surface consist of a peculiar white marl, evidently due in part to a fine detritus of pulverised coral. There is a coal overlying this coral reef in most places, and often lying directly upon it, and great *Stigmara* can be seen in the white marl in the hollows in the coral surface. This marl may be of some thickness and is sometimes more or less replaced by a light grey shale. This position for a coal, lying directly on a limestone, is unique in this area as far as my experience goes, and would tend to prove that the reef was formed in shallow water in the same way as corals occur at the present day, growing up to the surf region and becoming converted into land or lagoon conditions by the formation of a barrier of comminuted coral piled up by wave action.

The second limestone, which lies very close above the coral reef, varies from seven to eighteen feet in thickness. It is grey, hard, and from its marked nodular condition and the presence of signs of shrinkage, is probably somewhat dolomitic in character. The lower part, in which this character is most strongly developed, is full of minute fragments and ossicles of encrinites, and is usually overlaid by more calmy bands in which very large specimens of a horn coral are not uncommon. Polyzoa are frequent and (*Rhynchonella*) *pleurodon* is reported as being very abundant. The third limestone varies from two feet six to four feet thick, forming one or two extremely hard grey bands with a smooth surface and a clean splintery fracture. It is peculiar for so thin a limestone in having abundant large specimens of *Productus giganteus* which are well seen in section on the joint faces, and breaks up into large cubical blocks

with smooth, clean surfaces. One or more thin coals or coal positions invariably occur between this limestone and the next, which sometimes immediately overlies a coal and fire-clay.

In the Aberlady section this fourth limestone is just exposed on the beach in the middle of the small syncline near Aberlady Point, and is hard, bluish, and full of encrinites, but it is better seen further to the west near Craigielaw Point, where a greater thickness is exposed and where it contains *Productus giganteus* and is overlaid by dark shales. These shales, which are sometimes exposed at low tide, seem to be of considerable thickness, and at their seaward extension are baked against the sill of dolerite which terminates the section. A thin limestone near the margin of the sill has been turned into a white marble. At St Monans the limestone is about five feet thick, compact, bluish and encrinital, and is overlaid by a great mass of shale having calcareous nodules in its lower part and ironstones above. This shale is estimated to be fifty feet thick by Mr Kirkby. This great shale associated with this limestone is characteristic of this horizon, the whole forming probably the largest shale-limestone phase in the lower limestone series, and has been traced beyond these localities over wide areas. At Dunbar this limestone attains greater thickness, being estimated by Mr Clough at 18 feet. Here also it is overlaid by a great mass of shale in which a second thin limestone is developed. The peculiarity of this limestone at Dunbar, which otherwise has characters much like those described above, is the presence near the top of the limestone of a band consisting largely of *Saccamina carteri*. The absence of this band in the other sections, I believe to be due to the predominance of the shale over the limestone conditions, as where this peculiar band is found in this limestone along the eastern margin of the Midlothian basin, it is always associated with a large development of the limestone conditions, often far exceeding that seen at Dunbar, bands of limestone replacing in large measure the overlying shale mass.

We will next consider the vertical sections in the three localities, taking them in the following order:—Aberlady, St Monans, and Dunbar. The Aberlady section, according to the recent survey, is as follows:—

14. Dark shale with thin limestone of Craigielaw Point.
- D. 13. HARD GREY LIMESTONE, with encrinites and *Productus giganteus*.
12. Thin coal and fireclay.
11. Shale, 7 feet.

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- C. 10. HARD GREY LIMESTONE, with *Productus giganteus*, 4 feet.
  - 9. Thin coal in places.
  - 8. Shale, 4 feet.
  - 7. False-bedded sandstone, 4 feet.
  - 6. Sandy black shale, 8 feet.
- B. 5. NODULAR DOLOMITIC ENCRINITAL LIMESTONE, 12 feet.
  - 4. Coal, 10 inches.
  - 3. Grey shale and fireclay, 6 feet.
- A. 2. CORAL REEF LIMESTONE, 8 feet.
  - 1. Grey and greenish shale.

The vertical section of the St Monans beds is based on that of Mr Kirkby, published in the Survey Memoir for East Fife. The only alteration introduced into the section is the recognition of Mr Kirkby's "No. 53 pseudo-brecciated bed, light-coloured, calcareous, and very irregular in structure and containing crinoids"—as the No. 2 nodular encrinital limestone of Aberlady and Dunbar. Also a few separate items of shale and sandstone have been run together in one or two places.

St. Monans Section.

- 1. Sandstone, 40 feet.
- D. { 2. Dark shale with ironstones above, and limestone nodules beneath, crinoids and ostracods common, 50 feet.
- 3. CRINOIDAL LIMESTONE, 5 feet.
- 4. Shale, 2 feet.
- 5. Coaly fireclay, 6 inches.
- 6. Sandstone, 7 feet 6 inches.
- 7. Shale, grey, 6 inches.
- 8. Coal, 6 inches.
- 9. Fireclay, 3 feet.
- 10. Sandstone, 4 feet.
- 11. Fireclay and shale, 2 feet.
- 12. Coal, 4 inches.
- 13. Fireclay, 2 feet.
- 14. Sandstone and shale, 15 feet 9 inches.
- C. 15. LIMESTONE HARD, with *Productus giganteus*, 2 feet 6 inches.
- 16. Shale, dark, a coal has been worked here and stoops are left, 2 feet.
- 17. Sandstone, fireclay, and shale, 8 feet.
- B. 18. NODULAR DOLOMITIC ENCRINITAL LIMESTONE, 7 feet.
- 19. Dark fireclay, 2 feet.
- 20. Shale and sandstone, 3 feet.
- 21. Coal, hard, 6 inches.
- 22. White fireclay or marl, 6 feet 6 inches.

- A. 23. WHITE CORAL LIMESTONE, largely Lithostrotion, 18 feet.
- 24. Grey shale, with Lingula, Aviculopecten, Myacites, Myalina, Sanguinolites, etc., 4 feet.

The Dunbar section is taken from that drawn up by Mr Clough for the Summary of Progress, 1902.

- 15. Shale on thin flaggy sandstone, 70 feet to 80 feet.
- d. 14. Skateraw Upper Limestone, 1 foot to 2 feet.
- 13. Black shale, 3 feet to 5 feet.
- D. 12. SKATERAW MIDDLE LIMESTONE, 16 feet to 18 feet.
- 11. Coal, 4 inches to 6 inches.
- 10. Fireclay, 1 foot 6 inches.
- 9. Shale and fireclay, 6 feet 6 inches.
- C. 8. SKATERAW LOWER LIMESTONE, 2 feet to 4 feet.
- 7. Shale and sandstone, 23 feet.
- B. 6. LONGCRAIG UPPER LIMESTONE, 18 feet.
- 5. Shale, partly sandy, 2 feet to 5 feet.
- 4. Thin coal in places.
- A. 3. LONGCRAIG MIDDLE LIMESTONE, 3 feet.
- 2. Shale and sandstone, 25 feet.
- 1. Longcraig Lower Limestone mixed with bands of calcareous shale, 27 feet.

In these sections the limestones prefixed by A. B. C. D. are the four horizons indicated in this paper. The Lower Longcraig Limestone of the Dunbar section, I am inclined to look upon as really part of the coral reef horizon,—as an attempt at coral growth under bad conditions of muddy waters and shifting sandbanks, at length successful in the thin but good reef, three feet thick, forming the Middle Longcraig band. I am led to this opinion chiefly by the peculiar white marl which I have described as accompanying the coral reef limestone being also conspicuous between the muddy partings of this lower limestone. The Upper Skateraw Limestone is evidently part of the great shale-limestone phase noticed above, and two higher limestones which have not been considered in this paper are usually met with between this horizon and the Edge coals. In conclusion I may say that excellent descriptions of the coral reef or white limestone are given by Sir Archibald Geikie in his account of the sections at St Monans and Seafeld Tower, and that he also calls attention to the peculiar character of the nodular encrinital limestone in his account of the former section.

¹ See "Geological Survey Memoirs on the East of Fife," pp. 151, 152, and "Western Central Fife," p. 74.