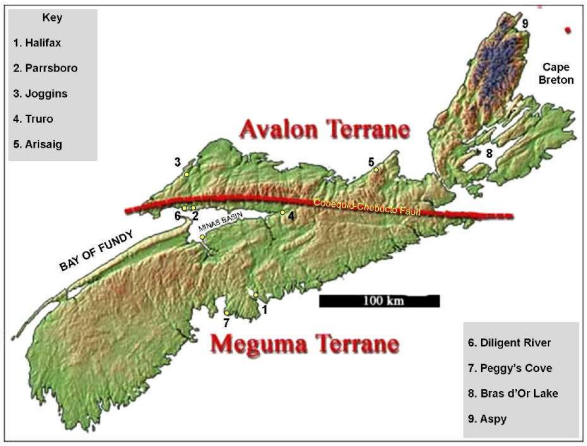
NOVA SCOTIA – A GEOLOGICAL TREASURE-HOUSE

Linda Drummond Harris

The Fundy Geological Museum is located at Parrsboro in Northern Nova Scotia and the road from Truro to Parrsboro follows an ancient fault system which at one time would have been as active as the San Andreas Fault in California. The Cobequid-Chebucto Fault neatly divides the province into two fundamentally different geological zones: the Avalon terrane to the north and the Meguma terrane to the south.



Nova Scotia's Avalon Zone was once a volcanic arc and part of Avalonia (present day northern Europe and Greenland) on the edge of the continent of Laurasia which became attached to the North American continental landmass during the Ordovician Period. The Meguma Zone, however, was attached to Gondwanaland and lay offshore from what is now northern Africa, where turbidity flows transported large volumes of sediment from the continental shelf, resulting in thick layers of sandstone and mudstone.

When the two great landmasses came together in the Devonian to form Pangea, the Avalon and Meguma terranes collided as the Acadian Orogeny gave rise to the Appalachian Mountains. The largest granitic intrusion in the Appalachians occurred in the Meguma terrane, forming a huge batholith revealed by subsequent massive erosion and covering a large part of southern Nova Scotia. Nowhere are these granite exposures more spectacular than along the southern coast to the west of Halifax at Peggy's Cove, *photo 1*.

Late in the Triassic, Pangea started to break up. Great rift valleys opened up, among them what was to become The Bay of Fundy. Had this rift continued to divide the land mass completely, then Nova Scotia might have become part of Europe, but instead it became attached to North America with the opening of the Atlantic Ocean in the Jurassic.

Into the Carboniferous period, Nova Scotia had a climate much like today's Persian Gulf, with a rapidly and

Photo 1: Peggy's Cove lighthouse stands on Devonian granite that has been smoothed, not only by the sea but by glaciers that retreated about 12,000 years ago. This granite was formed around the time of the earliest amphibians - older by about 160 million years than the earliest dinosaurs.
Photo: L Drummond Harris

repeatedly evaporated inland sea resulting in vast deposits of salt, gypsum, anhydrite and limestone. The area south and east of the Minas Basin is particularly dominated by karst topography with many flooded sink holes due to the underlying gypsum. In the later Carboniferous the climate was much wetter and land plants thrived, their remains forming rich coal measures. Both coal and gypsum mining are important to the Province's economy to this day, Nova Scotia being the world's leading exporter of gypsum.

The Joggins fossil cliffs became famous in 1851, when Charles Lyell, author of "The Principles of Geology", and Sir William Dawson, author of "Acadian Geology" and "Air Breathers of the Coal Period", visited the site. Joggins was already known for its abundance of fossilized tree trunks found in their original positions. When Dawson and Lyell examined one of these stumps, they noticed tiny bones. These apparently insignificant bones turned out to be one of the most important fossil finds in Nova Scotia. They were, in fact, the remains of one of the world's first reptiles, and the first evidence that land animals had lived during the "Coal Age".

Fossilized forests and fossil ferns can be found from Joggins throughout the Bay of Fundy. The fossil cliffs of Joggins are a world-class palaeontological site, *photo 2*. This area is subjected to some of the world's highest tides - over 15 metres. The tidal action causes steady erosion of the 23 metre high cliffs, constantly revealing new fossils. The cliffs have yielded fossils which give an unprecedented glimpse into life during the Carboniferous Period, including a rich variety of flora, a diverse

amphibian fauna, exciting Arthropleura trackways, *photo 3*, and some of the world's first reptiles.

Photo 2: Replica fossil and model exhibits at the Parrsboro Geological Museum
(Photograph: L Drummond-Harris)

Photo 3: This model of Arthropleura is on display at the Parrsboro Geological Museum.
(photograph: L Drummond-Harris)

From approximately 100,000 until 13,000 years ago, Nova Scotia was repeatedly scraped clean by multiple cycles of glaciation. Glacial striations can be seen all along the coastal areas and glacially deposited drumlins are a common sight. One superb example is Citadel Hill in central Halifax, its strategic location overlooking a deep glaciated harbour prompting Governor Cornwallis to choose this site for the capital in the mid 18th century.

To the east of mainland Nova Scotia lies the Island of Cape Breton, separated by the Canso Strait but artificially connected by a causeway. A saltwater estuary, the Bras d'Or Lake, dominates the centre of the island and its landmass slopes upward from south to north, culminating in the highlands (an extension of the Appalachians) of its northern cape. Here are to be found the oldest rocks in the whole region, dating back some 1.4 billion years and consisting of gneiss, amphibolite and marble. These Precambrian rocks represent the remnants of volcanic islands adjacent to a deep sea trench, similar to the Aleutian Islands west of Alaska. The island is heavily faulted, the most spectacular fault lying west of the North Aspy River. Geological evidence suggests that at least part of the island was originally joined with present-day Scotland - which is ironic as during the first half of the 19th century, Cape Breton Island experienced an influx of Highland Scots as a result of the Highland Clearances.

It was on our way back to Halifax from a tour of the Cape Breton Highlands that we took the road to the geological museum at Parrsboro and it was well worth the detour. Alas, there was no time to explore the fossil-rich cliffs at Joggins, or hunt for minerals along the Fundy Southern Shore, or see the amphibian tracks at Diligent River or visit the exposures of Silurian rocks at Arisaig, but the exhibits in the museum gave me an insight into the many geological treasures of this fascinating part of Canada. Anyone fancy a field trip?

RECONSTRUCTING ANCIENT CLIMATES

At the Earth Science Teachers' Association (ESTA) conference in Bristol last September, Dr. Howard Falcon-Lang from the Bristol Geology Department gave a very interesting lecture on Reconstructing Ancient Climates.

He said that four criteria were used to provide evidence for climates of the past, the fossil record, a study of palaeosols, and isotopes and constructing computer climate models.
He identified two periods in our Phanerozoic history of climatic extremes, the Carboniferous Icehouse and the Cretaceous Greenhouse

Carboniferous Icehouse: He used evidence from Joggins, Nova Scotia, the 400km coastal section of the Bay of Fundy which has a 17m tidal range. All the evidence, especially from the changing vegetation, points to marked cyclicity indicating fluctuations between glacials and interglacials. He suggested that there is a strong parallel between the Carboniferous and our current Quaternary.

Cretaceous Greenhouse: At this time all the evidence points to no ice at the Poles (scary analogue with 100 - 500 years in future?) An ice-free Earth affects ocean circulation, which becomes sluggish. There is an accelerated hydrological cycle and increased global rainfall, increasing both weathering and runoff. As part of the evidence, he mentioned that Cretaceous black shales are prevalent. These organic deposits are the result firstly, of lots of run-off from land to ocean creating organic-rich deposits; secondly, if oceans are sluggish then there is little oxygen in the deep oceans and therefore more black shale is preserved e.g. the source rock for Arabian oil around Tethys sea. Also, there were rain forests at both Poles in the Cretaceous, e.g. Monkey Puzzle trees. There were also dinosaurs in the Antarctic, but this region would have still lost light in winter, so did they migrate or hibernate?

Elizabeth Devon