GEOLOGY

Presence of Carbohydrates and Other Organic Compounds in Ancient Sedimentary Rocks

MOST investigators have been of the opinion that proteinaceous and carbohydrate materials that are deposited in marine and lake sediments cannot survive for long periods of time but are rapidly decomposed. However, in recent years several investigators have shown the presence of amino-acids in Tertiary shales[1] and in fossil shells and bones as old as the Devonian[2].

Preliminary studies have now demonstrated the presence of minute amounts of carbohydrate as well as proteinaceous substances in bituminous sedimentary rocks ranging in age from Ordovician to Tertiary. The reducing environment under which these sediments accumulated, coupled with the association between the organic compounds and finely divided inorganic matter, probably account for the preservation of these compounds.

Outcrop and well-core samples were thoroughly cleaned by immersion in chromic acid and subsequent washing with water. After being powdered, each sample (about 500 gm.) was treated with 0·5 *N* sulphuric acid for 8–10 hr. on a boiling water-bath. The hydrolysis mixture was neutralized with barium carbonate and freed from inorganic matter by ethanol precipitation and by ion-exchange resins. The hydrolysate from each sample was concentrated *in vacuo* and examined by paper chromatography. The following sugars were tentatively identified: glucose, xylose and arabinose, and possibly galactose and rhamnose (see Table 1). The concentration of glucose, which was the dominant component, expressed in mgm./kgm. of rock sample, varied from 0·14 for the Simpson to 1·3 for the Marcellus sample. In certain of the rock samples there was some indication of the presence of glycerol.

The glucose (180×10^6–300×10^6 years old), isolated from the Leonard and the Marcellus formations by the above treatment, was separated by paper chromatography (solvent: pyridine–ethyl acetate–water (2 : 5 : 7)) and characterized as the D-isomer by transforming it into N-*p*-nitrophenyl-β-D-glucosylamine, m.p. and mixed m.p. 184° C., $[\alpha]_D^{20}$ – 200° (approx.) in pyridine (*c*. 0·1)[3].

The mode of occurrence of the carbohydrate compounds in the rock formations is not yet known.

Table 1. CARBOHYDRATE COMPONENTS OF SEDIMENTARY ROCKS

Formation	Age	Component sugars				
		Glucose	Galactose	Arabinose	Xylose	Rhamnose
Stonehenge	Ordovician	+		(? +)	(? +)	
Simpson	Ordovician	+	(? +)	+	+	
Upper Chambersburg	Ordovician	+		(? +)		
Marcellus	Devonian	+	(? +)	+	+	+
Woodford	Upper-Devonian	+		+	+	
Des Moines	Pennsylvanian	+		+	+	
Missouri	Pennsylvanian	+				(? +)
Leonard	Permian	+	(? +)		+	
Schuler	Jurassic	+		+	+	
Green River	Eocene	+	(? +)		(? +)	
Elko	Miocene	+				

The rock was treated with hot 0·5 *N* sulphuric acid and the sugars identified chromatographically.

It has been shown, however, that in the case of a sample from the Marcellus formation, extraction with water yielded about 10 per cent of the total carbohydrate material as the free sugars, arabinose, glucose and xylose; the remaining undissolved carbohydrate material may be present in the polymeric form.

The amino-acids present in the acid hydrolysates of several rock samples were also investigated by paper chromatography. In comparing two core samples of shale of late Palæozoic age, the highly fossiliferous one of Pennsylvanian age appeared to contain alanine, glycine, valine, glutamic acid, aspartic acid, proline, leucine, cystine and tyrosine, whereas the non-fossiliferous shale of Permian age yielded only one amino-acid tentatively identified as aspartic acid. The amino-acids in the Pennsylvanian sample may be derived from fossil shell fragments.

Control experiments showed that neither the sugars nor the amino-acids arose from the materials used in the isolation techniques. These organic substances are believed to be original constituents of the rocks, although in the outcrop samples, despite careful collection and cleaning treatment, the possibility of surface contamination cannot be completely ruled out at present.

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Evidence for Tertiary Crustal Distortion in Mid-Argyll

REGIONAL deformation associated with the emplacement of Tertiary igneous rocks is well known in the British Isles. There appears to be some evidence in mid-Argyll, recorded on the one-inch maps of the Geological Survey of Scotland[1], which suggests that crustal distortion (broadly similar to that described from east Greenland by Wager and Deer[2]) may have occurred in this area during the Tertiary. This distortion is now reflected by a change in the trend of the Old Red Sandstone minor dyke swarm, the north-north-east–south-south-west tear-faults and, also, by variations in the strike of the Dalradian country-rocks; the district over which this change takes place coincides with the path of the Tertiary dyke swarm centred on Mull.

The Old Red Sandstone dyke swarm of the south-west Highlands has a north-north-east–south-south-west trend for most of its length[3]. However, just to the south of Loch Etive[1], a slight swing is seen and the dyke swarm traces out a gentle arcuate curve (Fig. 1). In the Craignish–Kilmartin area, twenty miles south-south-west of Loch Etive, the dykes have returned to their north-north-east–south-south-west trend; the greatest deflexion of the dykes from their normal orientation is about 15°. It is of importance