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PRE-CAMBRIAN OF NORTH-WESTERN QUEENSLAND.

PRESENTED AT ANZAAS, MELBOURNE 22/8/55.

by

E. K. Carter.

THE PRE-CAMBRIAN OF NORTH-WESTERN QUEENSLAND

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With two exceptions all the rocks in North-western Queensland which are regarded as Pre-Cambrian in age crop out between the Northern Territory border and Longitude 141°E and north of latitude 22°S. The exceptions are Mt. Brown and Mt. Fort Bowen, some 18 miles apart and roughly 120 miles north-east of Cloncurry. They project above the black soil plains and are each less than one square mile in outcrop area. The main region of Pre-Cambrian is shown on the slide by the various types of hatching, as will be explained later.

Two regional surveys have been carried out in the region over the last five years. The mineralized belts and the adjoining strongly to moderately deformed areas, constituting in all some 22,000 square miles, were mapped by joint Bureau of Mineral Resources & Geological Survey of Queensland teams between 1950 and 1954. The younger rocks, consisting of Pre-Cambrian Pilpah Sandstone, the Upper Proterozoic or Lower Cambrian Camooweal Dolomite and the widespread Middle and Upper Cambrian sediments were mapped by Dr. A.A. Opik and others of the Bureau of Mineral Resources. These are, with the exception of the Cambrian sediments between Dajarra and Selwyn, all believed to be on a Pre-Cambrian basement which formed the craton to the Pre-Cambrian geosynclines of the region.

The region may be divided into four major tectonic units.

Firstly, there is the craton or stable block marginal to which the other three units were formed and against which their sediments or lavas (as the case may be) were folded. I should explain that throughout this paper I have, in general, used Marshall Kay's terminology as defined in his "North American Geosynclines". The cratonic area is indicated on the screen by the stippling. It represents an easterly extension of the larger block against which the Pre-Cambrian geosynclines of the Northern Territory were also folded.

No rocks are known which can be attributed with certainty to the cratonic basement. Scattered outcrops of granite, gneiss and schist over an area of a few square miles, 25 miles west-south-west of Mt. Isa may belong to the basement. The sedimentation and structural pattern in the outcropping Pre-Cambrian rocks leaves little doubt, however, that the craton throughout the whole of Proterozoic time lay roughly in the position indicated. In detail changes undoubtedly occurred along the margin of the craton.

None of the sedimentary rocks which lie on the craton - they range in age from probably Lower Proterozoic to Tertiary - show strong linear trends, except near its eastern edge. Dips greater than 30° are not common. I have shown the craton as extending to within 25 miles of Mt. Isa. The structural pattern and sedimentation evidence from rocks of Unit 2 suggests that craton was probably a controlling factor at least as far east as Mount Isa.

The second tectonic unit is the north-south trending eugeosyncline just referred to as Unit 2. It is shown on the screen by the vertical hatching. Rocks of this geosynclinal pile crop out over a length of 200 miles and a maximum width of 120 miles. They are bounded on all sides by younger rocks, soil or alluvium. Their total thickness may be to the order of 40,000 feet, but the basement rocks are not exposed within the geosynclinal area.

Features of this tectonic unit include:-(a) The high proportion of lavas - both acid and basic - within the geosynclinal pile. (b) The absence of evidence of any sedimentation from the east. (c) Its structural symmetry in cross-section. Strong compression resulted in overthrusting from the east of Cloncurry and overthrusting from the west near Mt. Isa.

The conclusion is therefore reached that a rigid block lay to the east of the geosyncline, as well as to the west, but that it did not form a land mass.

The history of the eugeosyncline may be briefly stated as follows:-

1. Extensive sheets of acid flows were poured out over a land surface. Points of extrusion of the lava are not known, nor are its eastern and western limits.

2. Subsidence towards the close of the cycle of acid lava outpourings permitted the interbedding of sediments with the acid lavas which soon gave place to basalts. Sedimentation was continuous during the transition in lava types, except locally near the western edge of the main geosynclinal area. Sinking of the geosyncline was apparently effected by downfaulting along a series of near-meridional faults on its western side. The basalt appears to have been extruded through a most extensive fracture system now clearly revealed as dyke swarms wherever the acid lavas are exposed.

3. The period of tension was succeeded by a period of updoming which produced tectonic land, the most pronounced and persistent ridge of which was centred roughly along Longitude 139°45'E, some 15 miles east of Mt. Isa, in the latitude of Mt. Isa.

4. Erosion of the tectonic land gave rise to the very extensive carbonate rocks, with some argillaceous, sandy and carbonaceous sediments, which today are represented largely by skarn rocks and associated schists and quartzites. The basic volcanic activity gradually drew to a close during this period. The skarn rock succession lies with only a slight angular unconformity on the rocks beneath, but in the central portion of the geosyncline it lies directly on acid lavas.

5. A period of strong folding, presumably accompanied by general uplift, produced the first general break in sedimentation since the geosyncline developed. Shear faulting developed on a regional scale at the same time.

6. Renewed sedimentation gave rise to a succession, of quartzites with some interbedded limestones, which was not less than 5,000 feet thick. These occur today only as remnants in basins in the central portion of the geosyncline but the grade of metamorphism of the underlying rocks and the degree to which the latter have been intruded by granite show that the quartzite succession must once have covered the whole area.

7. Strong folding produced dips up to 80°, but generally 50°-70°, in the last-deposited quartzitic succession. Granite was not emplaced until after the sediments of the third tectonic unit were laid down.

The age relationship of the younger rocks of unit 2 to the sediments of unit 3 has not been established as they are nowhere in contact. The matter is, however, discussed further later in this paper.

The third tectonic unit is indicated on the screen by the diagonal hatching. It was a geosyncline marginal to the main area of the eugeosyncline and apparently derived its material from both the tectonic land to the east and south-east and from the craton to the west and south-west. It is virtually devoid of volcanic

activity. It therefore appears to have been a miogeosyncline. Its sediments - sandstone, shale and carbonates - unconformably overlie the basalts of the eugeosyncline. During sedimentation strong east-west downwarping occurred in places but the final folding was on north-south axes. The miogeosyncline appears to have been bounded on both the east and the west by roughly meridional faults. The cross-warping did not extend east of the eastern boundary fault.

The western margin, near Longitude 139°10'E in the latitude of Camooweal, is marked by an abrupt change in the type of folding. To the east the sediments have pronounced linear trends while to the west they are folded into basin and dome structures in which the dip of the bedding rarely exceeds 30°. Sedimentation appears to have been continuous across the dividing line. West of the miogeosyncline the sediments were deposited in a shelf environment. They are probably thinner, more arenaceous and better sorted than farther east. The maximum thickness of sediments within the miogeosyncline is not less than 30,000 feet, where downwarping was strongest.

Metamorphism of the miogeosynclinal sediments is slight relative to those of the eugeosyncline to the east, including those in the youngest succession, which unconformably overlies the skarn and volcanic rocks. On the other hand the type and intensity of folding of the youngest succession in the eugeosyncline and of the miogeosynclinal sediments are comparable. Their depositional environments, as reflected in the rock types, are markedly different, but both lie unconformably on older rocks of the eugeosyncline. The same granite which intrudes the rocks of tectonic unit No.2 intrudes the sediments of unit 3. A contact between granite and the uppermost quartzitic succession of unit 2 has not been observed but in the course of check work in recent weeks an intrusive pegmatite was discovered.

On the evidence at our disposal the age of the sediments of the miogeosyncline relative to the rocks of tectonic unit 2 cannot be definitely stated but it is suggested that the uppermost quartzitic succession of Unit 2 and the miogeosynclinal sediments are pene-contemporaneous in part at least.

The Mount Isa Shales are considered to mark a limited pre-orogenic sedimentation in a narrow trough between the tectonic land of the eugeosyncline to the east and the craton to the west, that is, a foredeep. The Mount Isa Shales, contrary to the author's previous view, are younger than the sediments of both the eugeosyncline (the second tectonic unit) and the miogeosyncline (unit No. three) and strictly form a separate tectonic unit, though related to the major geosynclinal and orogenic processes which gave rise to units 2 and 3.

The fourth major tectonic unit was probably formed considerably later than the other three. It consists of an east-west trending geosyncline north of the Nicholson River (the horizontally-hatched area) and associated shelf deposits farther south - the Constance Beds. The Constance Beds lie with a strong unconformity on sediments of the same age as those of unit 3, and are regarded as Upper Proterozoic in age.

The geosynclinal pile contains acid lavas with some intermediate and basic types, arenaceous and carbonate rocks and a thick development of arkose and greywacke with pebble beds. Several thousand feet of sediments and lavas have been observed.

Dips are generally low(commonly 15°) and folds are open, but in the vicinity of prominent east-west faults dips of 80° have been measured. The grade of metamorphism is low. The geosynclinal pile has been intruded by granite.

The portion of unit 4 mapped in Queensland is believed to mark the eastern end only of a geosyncline which probably extended at least as far west-north-west as the MacArthur and

Limmen Bight Rivers.

With the exception of the Camooweal Dolomite, which is gently folded, only fragmentary records remain of any later Pre-Cambrian sedimentation.

AGES OF THE TECTONIC UNITS

The ages of the various rock units cannot be accurately fixed. The Camooweal Dolomite underlies Middle Cambrian sediments with a pronounced unconformity. It is unfossiliferous but is regarded as probably an intra-continental deposit. It could be either Lower Cambrian or Upper Proterozoic in age. Unconformably below the Camooweal Dolomite are two arenaceous successions- the Constance Beds and the Pilpah Sandstone, which occupy two separate areas to the north and east respectively of the Camooweal Dolomite. They can reasonably be regarded as Upper Proterozoic in age. Most of the other major Pre-Cambrian units in the region can be demonstrated to lie stratigraphically below either the Pilpah Sandstone or the Constance Beds.

The lower limit for the age of the rocks in the region cannot be so definitely fixed. The age of monazite from pegmatite near Mt. Isa which marks a late stage in the intrusion of the main granite masses was determined by Holmes and Smales to be between 1000 and 1200 million years. Assuming that all losses of uranium due to weathering were of recent date, the conclusion was reached that the most probable age of the pegmatite was 1200 million years. However this assumption is not warranted as the level of Middle Cambrian sediments a few miles to the west shows that the pegmatite would have been within reach of weathering processes as early as that date.

The figure of 1000 million years implies that all the pre-granite sediments and lavas in units 2 and 3 are Archaean in age.

The author of this paper takes the view, however, that the geological evidence favours a younger age than Archaean for the rocks of units 2 and 3 and that the status of age determination by radioactive element ratio methods is not such that age determinations by these methods can be accepted reservedly. The basement rocks of unit 1 are presumably Archaean in age. Two distinct and unrelated tectonic cycles are recorded in the rocks of units 2 and 3 on the one hand and unit 4 on the other. Units 2 and 3 are considered to represent separate phases of the one continuing process and to have been stabilized by one period of granite emplacement. (Granite emplacement itself took place in two separate, though probably not widely spaced, episodes, in point of time.)

We do not know the time interval which elapsed between the orogenies responsible for the incoming of granite into the rocks of units 2 and 3 on the one hand - the north-south trending geosynclines - and unit 4 on the other - the east-west trending geosyncline - but there is not a strongly marked metamorphic discordance between the rocks of units 3 and 4. This suggests that there was not a prolonged period of deep erosion between the two.

Further, the rocks of the eugeosynclinal pile are quite in character with those of Palaeozoic and later geosynclines, in regard to thickness of sediments and lavas, structure, types of metamorphism, and absence of universal granitization. A possible point of difference is, however, the high proportion of lavas to sediments.

It is concluded that the rocks of unit 4 are Upper Proterozoic in age and that those of units 3 and 2 are most probably Lower Proterozoic.

PRE-CAMBRIAN TECTONIC UNITS OF NORTH-WESTERN QUEENSLAND

GULF OF CARPENTARIA

NORTHERN TERRITORY

BURKETOWN

NORMANTON

DOBBYN

CAMOOWEAL

MT ISA

CLONCURRY

McKINLAY

URANDANGI

SELWYN

DAJARRA

JULIA CREEK

BOULIA

Reference

1 — Craton

2 — Lower Proterozoic Eugeosyncline

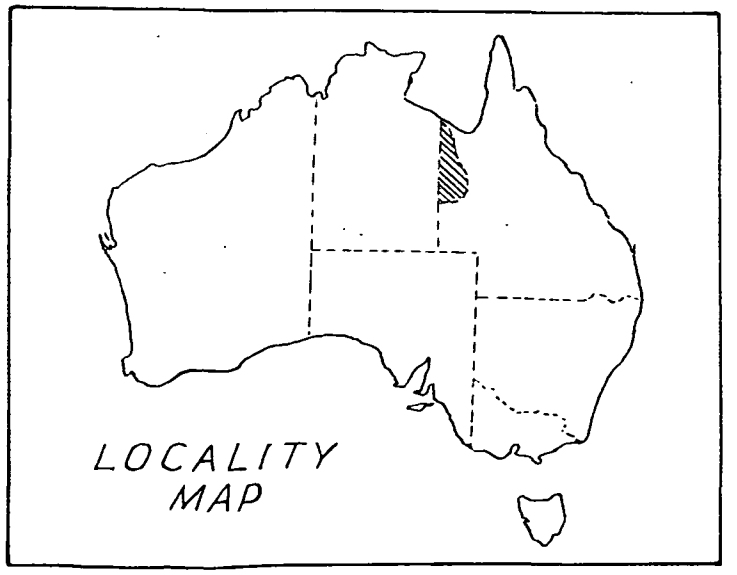
3 — Lower Proterozoic Miogeosyncline

4 — Upper Proterozoic Eugeosyncline

Regional Fault or Fault zone

SCALE OF MILES

50 0 50 100



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