SOME NOTES ON PRECAMBRIAN STRUCTURES IN ARIZONA

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GENERAL

The Precambrian rocks of Arizona consist of two major systems: an older, lower group which is a schist-intrusive complex, and a younger, upper group of relatively unmetamorphosed sedimentary rocks. These rocks outcrop most abundantly along the southwest edge of the Colorado Plateau along a zone about 450 miles in length extending from the Arizona-Nevada boundary to the southeastern corner of the state.

1. Lower group

The complex nature of the lower group requires extremely detailed field structural studies prior to intelligent evaluation of its basic structure. Except in a few small widely separated areas, little work of this nature has been done.

Early work of Ransome (1), Ross (2), and others, has lead to the general belief that most structural trends in the lower group are oriented northeast-southwest, a concept that has been mainly derived by scattered measurements of schistosity and foliation trends in the Globe-Miami-Superior, Stanley-Aravaipa districts, and a few other scattered areas. In southern Yuma County Wilson (3) describes general northeast-southwest foliation trends in schists which outcrop in most of the mountain ranges of that area and are assumed to be Precambrian. At Morenci Lindgren (4). reports Precambrian schists with foliation of highly variable trend which have been almost obliterated by Precambrian granites. He appears to consider the pronounced northeast-southwest elongation of the Laramide quartz monzonite porphyries as having been due to their following a Precambrian schist foliation trend which he hypothesizes to be about northeast.

Recent work in the Little Dragoon Mountains (5) in a group of intricately folded, dynamically metamorphosed greenstones, rhyolites, arkoses, and shales reinforces this belief, for here axial-plane foliation strikes about N45°E.

Yet at Bisbee, Ransome (6) reports Precambrian schists having a highly variable foliation trend. However, he believed the main trend to be north-northeast-south-southwest.

Jagger and Palache (7) show similar north-northeast-south-southwest trends in the Bradshaw Mountain area far to the north, and recent work by the U. S. Geological Survey (5) indicates that in the Prescott-Jerome and Bagdad areas general north-south trends of foliation, folding, and strong faulting exist. These have been measured in moderately metamorphosed andesites, rhyolites, pyroclastics, and sediments. In addition, some of the faults have been intruded by plutons, all clearly Precambrian in age. Work by Wilson (8) in the Mazatzal Mountains with a series of weakly dynamically metamorphosed greenstones, rhyolites, shales, grits, quartzites, and conglomerates has demonstrated that folding there trends north to northeast. In addition, low angle southeast dipping thrust faults exist which Wilson believes are strongly indicative of northwest thrusting. However, Anderson (5) interprets these as resulting from east-west regional compression.

From all this it can be clearly seen that the general concept of a northeast-southwest trend for most "lower group" Precambrian rocks in Arizona may be in part unjustified. Locally there are strong deviations from this trend, and

this should be taken into consideration in all future regional structure analyses. North-south trends may be just as important.

2. Upper group

The upper group of relatively unmetamorphosed sedimentary Precambrian rocks are intruded by vast diabase sills of debatable age and uncomformably overlie the ancient schist-intrusive complex, and outcrop in two separate areas of Arizona. The largest and best known area is in east-central Arizona where this group is known as the Apache group (maximum known thickness is 1800 feet including the diabase). The other area located in the depths of the Grand Canyon upstream from the Granite Gorge was examined by Darton (9) who considers it to be, in part at least, equivalent in age to the Apache group farther south. The formations that are considered to be correlatible with the Apache group are found in a section of strata called the Unkar group (about 4700 feet thick).

Just when the diabase was intruded into these thick groups of sediments is not known. Evidence collected by Cooper (10) in the Little Dragoon Mountains definitely indicates a small part to be Precambrian, but as Wilson (11) has pointed out, workers elsewhere, particularly in the Globe-Miami-Superior-Ray districts, have shown it to be definitely as young as late Paleozoic, with a fair probability of being Mesozoic or even early Tertiary. Quite possibly several different invasions of diabase occured; nevertheless, its distribution relative to ancient fractures in the Precambrian basement along which it could have irrupted still remains an enigma, which when given further study, as it should, may yield a wealth of structural information which could have important economic significance with respect to Arizona's mining future. The same fractures from which diabase irrupted might have similarly served as focal points or channels for the later Laramide felsic and intermediate intrusives which have provided Arizona with much of her mineral wealth.

Perhaps the most interesting feature of the sediments of this upper Precambrian group is their general outcrop pattern. The strata of the Apache group outcrop is a semi-continuous band for about 160 miles extending in a north-northwest-south-southeast direction in east central Arizona. When this trend is extended northward it crosses the Grand Canyon area at the point where the Unkar group is found. It seems probable the two groups form a single stratigraphic sequence connected beneath the southwestern edge of the Colorado Plateau where it is buried deeply from our view. The general north-south characteristic of this trend seems deserving of mention. These sediments could have been deposited in a general north-south-trending trough which lay across the state in very late Precambrian time. Could this trough be a part of the great south-southeast-trending Beltian trough which extended down from Canada across western Montana, Idaho, and western Utah in Proterozoic times (12)? It seems quite possible. If so, it is another indication that north-south trends are very significant basic structural features in Arizona.

HYPOTHETICALLY RELATED STRUCTURES ON THE CONTINENTAL SCALE

Study of Eardley's tectonic maps of the Paleozoic in his "Structural Geology of North America" (12) suggests that these north-south and northeast-southwest trends were important structural factors during much of the Paleozoic also.

The Paleozoic Cordilleran seas which filled a variety of north-south elongated troughs extending from the Canadian boundary to southeastern California, and the Trans Continental Arch which extended northeast from northwestern New Mexico and northeastern Arizona to southern Ontario Province may be related later expressions of these fundamental underlying Precambrian structures

Also, the two most active orogenic belts during during the Paleozoic Era were the north-northwest-south-southeast-trending volcanic archipelago along

the present western coastline of the United States and northern Mexico, and the northeast-southwest-trending Appalachian-Llanorian belt, which extended at least 3000 miles from Newfoundland to northeastern Mexico. These belts may have converged into the vicinity of the volcanic fields of modern central Mexico, forming a gigantic "V" embracing most of the present North American continent.

It seems then, that general north-south and northeast-southwest structures were fundamental in the paleotectonic development of the continent, and consequently their manifestation in the Precambrian of Arizona is not at all surprising, particularly as Arizona lies only about 700 miles from the apex of the hypothetical "V".

If then, these are fundamental structures, ought we not look for significant later intrusive activity and metallization in areas where they intersect?

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