HIGHLIGHTS OF NORTHEASTERN OREGON GEOLOGY

N. S. WAGNER, June, 1958.

The map on page ____ pictures the distribution of the dominant rock types occuring in northeastern Oregon. Beginning with the oldest, these are as follows:

Pre-Tertiary sediments and metamorphics: The rocks of this group include a thick and varied series of marine sediments, minor amounts of other sediments which may have been deposited in fresh, or brackish waters, lavas, volcanic tuffs and various igneous intrusives, the principle one of which is gabbro. The intrusive occurrences are fairly numerous but tend to be small. They have therefore been included with the sediments rather than shown separately for the sake of minimizing drafting complications on a map of this scale.

All of these rocks have been subjected to the tremendous pressures and squeezings and shiftings that characterize some types of mountain building and most of them display varying amounts of both regional and contact metamorphism. As a consequence of these events, ~~these formations~~ the sedimentary formations exist in a profoundly folded and faulted condition and the fossil evidence needed for dating has been largely obliterated. Such fossil evidence as has been found, however, shows quite conclusively that the bulk of the sediments and their associated volcanics were formed during the Permian and Triassic periods of geologic time (see Geologic Time Chart, page ____). Other evidence suggests the possibility that some Jurassic and pre-Permian Paleozoic sediments might also be present in places, but this evidence is as yet not conclusive. The assigned dates for the associated intrusives vary considerably. This is undoubtedly due in some instances to the difficulty of establishing a precise age for the intruded sediments, but considering the small size and the wide distribution of these intrusives, it is altogether likely, and probable, that emplacement of individual occurrences took place at many different times. In any event, all assigned dates are pre-

Cretaceous and most are early Mesozoic.

Pre-Tertiary "Granites": "Granite" is the local name by which the rocks of this group are almost universally called. From a technical standpoint however, the rocks shown here are not true granites. Instead, they are comprised of several closely related crystalline types known as tonalites, diorites, granodiorites and quartz diorites. Like granite, these rocks originated from magmas situated deep within the earth prior to the time the crustal distortions of mountain building permitted escape to higher horizons. The emplacement of rocks of this type was formerly thought to have come about wholly by means of physical intrusion of the magma and hence rocks of this type are commonly referred to as intrusives. It is now believed that some of these crystallines were formed in part as a result of alteration and recrystallization of receptive segments of the intruded strata by chemically charged solutions emanating from the magmas. Contact pegmatites and tactites are frequently found around the margins of these occurrences.

Most, but not all, of the crystallines represented here are classified as having been emplaced during the Cretaceous period. In the instance of those in the Elkhorn range, west of Baker, the age had been narrowed down rather positively to early Cretaceous. By the end of the period, and at the beginning of Tertiary time, these "granites" and the other pre-Tertiary formations, were exposed in a series of towering mountain peaks.

Tertiary Rhyolites and related volcanics: As suggested by the heading, this group is characterized by lavas, tuff, tuff breccias and agglomerates with compositions that are predominately acidic. The lavas include rhyolites, dacites, andesites and their related porphyries. The clastics include deposits built up both on land and under water. Some interbeds of basalt and lakebed sediments do also occur with the rocks of this group in such a manner that they cannot be depicted separately on a map of the present scale. These are not too abundant but they nevertheless are present. Otherwise Tertiary basalts and

lakebeds are included in separate groups and described later.

Most of the rocks mapped as part of this group are classed as belonging to Eocene time though some occurrences are dated in the Miocene. The celebrated Clarno and John Day formations make up the bulk of the mapped occurrences shown in the western portion of the area.

Many of the individual rock members of this group appear fresh and glassy. Others, particularly some tuffs, show the weathering and devitrification effects normal to unstable glasses, or the alterations induced by local hot spring activity. No vestige of the metamorphism found with the pre-Tertiary sediments is present. Instead, greater than normal fracturing and the tilting and brecciation of folding and faulting constitutes the usual type of post-depositional deformation exhibited by rocks of this group. These rocks, do as a whole, however, show a greater amount of structural shattering than do the later basalts and lakebeds.

Tertiary Basalts and Basaltic Andesites: These lavas rate as perhaps the most impressive and the most distinctive of the rock types found in the area, particularly to tourists who are unaccustomed to scenery dominated by rock of this kind. The group is also the most widespread in its occurrence.

There are three principle modes of occurrence in which these rocks are found. One is in the form of a tremendously thick succession of superimposed flows. The second is represented by isolated occurrences involving only two or three flows, and sometimes only a single flow. Thirdly, there are the dikes which now occupy the channels from which the surface flows were originally fed. Of these modes of occurrence, the thick succession is by far the most prevalent and the dikes are the scarcest.

The succession of superimposed flows is part of the great northwestern shield which blankets large portions of Washington, Oregon and Idaho, and which rates as one of the major examples of lava flooding in the world. This shield is represented in northeastern Oregon by the basalts shown in the northern

and western portions of the map. Generally speaking, this shield type of occurrence peters out against the Blue Mountains, some of the higher portions of which were probably never completely burried. The aggregate thickness of the shield flows amounts to several thousands of feet. This is well illustrated by the fact that member flows are exposed along the bank of the Columbia River in the extreme northwest corner of the map where the lowest elevation in the area occurs, yet at the same time the accumulation has been so great that later flows of the series occur on some of the highest portions of the mountain ranges situated to the south and east of Pendleton. In addition, the base of the series is not known to have been penetrated by any well yet drilled in the portion of the Columbia Basin occurring within the mapped area. Other striking examples of the enormous thickness of the series are to be seen in the canyons of the Snake and Imnaha Rivers east of Enterprise.

The occurrences comprised of just one or two flows are most prominent in the southeastern section of the map in the area north and west of Ontario, These, too, give rise to some very picturesque scenic effects, especially where they form the "table top" caps to eroded lake bed remnants.

The phenomena of columnar jointing rates as one of the most impressive features of these basalts. This is a function of cooling which results in the formation of multisided (usually five) columns which may be seen in sizes ranging from a few inches to two or more feet in diameter. Not all basalts exhibit this feature, but when they do the effect is conspicuous.

Some of the basalts in the area northwest of Ontario are dated as Pleistocene in age. Others in the same area are recognized as Pliocene and Mio-Pliocene. Roughly speaking, however, the age of emplacement increases to the west and the great plateau series is generally accepted as predominantly Miocene. Some basalts are known to have been extruded in central Oregon durin the Eocene in association with the other members of the Clarno formation. It is possible that a few small occurrences of basalts of this age are represented

in northeastern Oregon in a place or two, especially in some areas where the rhyolite group is abundantly present.

Tertiary Lake Beds: These are sediments deposited in shallow fresh water lakes. They are comprised largely of the normal products of erosion such as silts, muds, sands and pebbles from the surrounding terrain, but in places they also contain extensive interbeds of diatomite and volcanic ash. In addition there are occasional interbeds of poor grade coal. Contained fossils, other than those represented by the diatomite and coal, consist of several kinds of fresh water gastropods and clams, crustacions, fish, leaves, woods and the remains of terrestrial vertebrates.

The degree of post-depositional consolidation experienced by these sediments varies, but at best this has not been great. As a consequence, the sediments erode quite easily and some even slack down into soil quite readily. Exposures are therefore frequently obscure. When they are visible for examination however, the original details of the bedding and other phenomena of deposition can be seen in an excellent state of preservation. The contrast between these sediments and the metamorphosed pre-Tertiary sediments is thus quite great.

Fossil studies show that these sediments were accumulated throughout the whole of Tertiary time. For example, the occurrence immediately south of Pendleton, which is an intermixture of shallow lake bed and fluvatile sediments and fanglomeritic rubble, is dated quite precisely as middle Pliocene on the strength of a veritable graveyard of vertebrate remains found near the McKay resevoir, yet fossil ferns and other leaves show that the small occurrence next south is Eocene. The scattered occurrences in the Baker area are largely Miocene and those in the southeastern portion of the map are both Miocene and Pliocene.

While most of the large, well-exposed sedimentary deposits are shown

on the map, Tertiary sediments are actually more abundant and more widespread in their occurrence than is indicated. They occur wherever the lavas are shown, but they are present in the form of thin interbeds and are usually very restricted in their lateral extent. Their value in dating the associated volcanics is great even though they cannot be shown here.

Pleistocene to Recent: The geologic present is always with us. In northeastern Oregon its dominant aspect is erosion, and has been since the close of Tertiary time. It is perhaps safe to say that most of the products of this erosion have been carried to points outside the area. However, local deposition has always been made in certain select areas where the streams have been confronted with temporary base-level conditions. Such deposition is going on today. Furthermore it will continue to go on in the future, whenever and wherever conditions permit, as long as rains fall and streams flow.

Only the major areas where the products of present, recent, and near-recent erosion have been deposited, are shown on the map. The materials represented in these areas are principly fluviatile sands and gravels and clays in the instance of the major valleys, but the erosional debris of glaciation is represented also in the instance of some of the occurrences located in the Elkhorn and Wallowa mountains.

Mineral Deposits: Gold, silver, copper and many other kinds of metalliferous mineral deposits are found in the area. Nonmetallic mineral occurrences of note include limestone, gypsum, diatomite, perlite.

The distribution of these minerals is very definitely linked with the distribution of bedrock types. For example, all the in-place occurrences of metalliferous minerals are found only in areas occupied by the pre-Tertiary metamorphics and granites, excepting for a few cinnabar prospects and one known stibnite prospect found in rocks of the Tertiary rhyolite group. The occurrences of limestone and gypsum are restricted exclusively to the areas

occupied by the pre-Tertiary metamorphic rocks. The perlite is found in the areas occupied by the Tertiary rhyolites and their related sediments. All diatomite is associated with the Tertiary lakebeds.

The Tertiary basalts are the only bedrock group not mentioned in the foregoing paragraph as having some sort contained, or associated, mineral resource of potential value. This group is notoriously barren however, the only claim to worth for basalt being for the rock itself for road metal uses. No one knows what valuable mineral deposits may be present in the basement rocks underlying these flows, but there could be several. Of the presently known mineral resources in the area, gold and limestone are by far the most important. The intrinsic value of each is great.

Gold was the first mineral to be mined in northeastern Oregon. Its production began in Griffith Gulch, a few miles west of Baker, in 1861. From then until the mines were closed by a so-called "Defense" order issued in 1942 at the commencement of United States participation in World War II, gold mining constituted the most important mining activity in the area. The area has produced an estimated two thirds of the state's total gold production, which according to the U. S. Bureau of Mines (Minerals Year Book for 1943) amounted to 5,668,118 ounces for the period 1848 through 1943.

Practically all the gold mines are inactive today. This is due not necessarily to the lack of potential ore reserves in the mines, or to disinterest in mining on the part of the owners, but to an adverse economic climate created by the fact that gold is still priced at its pre-Pearl Harbour level despite the tremendous cost-of-operation increases that have taken place since. Under these circumstances, there are very few gold mines that can be operated successfully even though their productive capacities are still essentially as good as they were during the pre-war period. The condition of enforced idleness will doubtless continue until such time as the economic dilemma is resolved.

Limestone is being quarried at four places. Three of these are in Baker County. The other is in Wallowa County. The rock produced from these operations is being used for sugar refining, paper processing, and the manufacture of cement and carbide. Production for cement manufacture has been going on since sometime in the 1920's and early 1930's, but production for all the other uses comes from operations which have been established since 1950.

Whereas sand and gravel deposits are not rated as mineral resources in the same sense of the word as are gold, and limestone occurrences, the yearly production of these materials is nevertheless great in both amount and value. Furthermore, the availability of high quality occurrences suitable for aggregate use is of great importance to the communities in which they occur. The Pleistocene to Recent areas of deposition support some notably important aggregate-producing operations in the Columbia River basin area northwest of Pendleton and along the Snake River in the vicinity of Ontario.

Summary: The rock units described here, and shown on the map (page ____), represent the dominant lithologic types of material comprising the bedrock in northeastern Oregon. They also illustrate certain broad aspects of the age relationships existing between the various groups of rock types. In this respect, the distinction between rock units belonging to the Cenozoic and pre-Cenozoic eras is most noteworthy in that the location and distribution of all known pre-Cenozoic exposures of importance is indicated on the map.

GEOLOGIC TIME CHART

ERA	PERIOD	EPOCH	OROGENIC EVENTS	DOMINANT LIFE: ANIMAL	DOMINANT LIFE: PLANT	DURATION (Figures are Millions)	BEGINNING YEARS AGO (Figures are Millions)
CENOZOIC	QUATERNARY	RECENT		Man		25000 Years	25000 Years
		PLEISTOCENE	Cascadian Revolution			1	1
	TERTIARY	PLIOCENE				11	12
		MIOCENE			Deciduous Trees	18	30
		OLIGOCENE		Mammals Birds		10	40
		EOCENE				15	55
		PALEOCENE				5	60
MESOZOIC	CRETACEOUS		Laramide Revolution			55	115
	JURASSIC		Nevadian Disturbance	Reptiles	Conifers Cycads Gingkos	40	155
	TRIASSIC		Palisade Disturbance			35	190
PALEOZOIC	PERMIAN		Appalachian Revolution		Scale Trees Cordaites Seed Ferns	30	220
	PENNSYLVAN'N (CARBONIFEROUS)			Amphibians		30	250
	MISSISSIPIAN (CARBONIFEROUS)					30	280
	DEVONIAN		Acadian Disturbance	Beginning of Spiders and Insects; Fishes; Corals	Ferns and Seed Ferns	40	320
	SILURIAN					30	350
	ORDOVICIAN		Taconian Disturbance	Higher Invertebrates including Trilobites		60	410
	CAMBRIAN					80	490
PROTEROZOIC	KEWEENAWAN		Killarney Revolution				
	HURONIAN			Worms and other Soft-tissued Forms	Algae	1300	
CRYPTOZOIC EON (PRE-CAMBRIAN)	TIMISKAMIAN		Algonkian Revolution				
ARCHEOZOIC	KEEWATIN		Laurentian Revolution				Oldest known rocks 1800

TIME CURVE

Compiled by L.F. Heuperman

0 — 100 — 200 — 300 — 400 — 500 Million Years

SCALE of TIME

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* I am not sure of the proper wording for the Hogenson and Trauger references. You had best check these.

** Eugene Hampton specified in his letter that credit was to be given in the manner indicated here. If you don't like it, check with him for clearance for some other form of wording.