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GEOLOGY OF THE ECOLA STATE PARK LANDSLIDE AREA, OREGON

by

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During February 1961 a large mass of earth began sliding seaward at Ecola State Park on the coast of Clatsop County, Oregon (figure 1). The slide virtually destroyed the parking and picnic areas and dumped much of the ground into the sea. The area involved was more than half a mile long and covered approximately 125 acres (see accompanying map). Because of salvage operations and unsafe roads, the State Parks and Recreation Division has closed the entire area to the public for an indefinite length of time.

Nature of the Slide

The sliding action occurred as a slow, glacierlike movement continuing over a period of about two weeks. During the early stages the motion was at a rate of about 3 feet per day, but it gradually diminished and finally ceased.

Vertical displacement was the greatest at the head of the slide where the surface dropped roughly 40 feet. Horizontal movement was the most noticeable between the parking areas and the toe of the slide. One of the more spectacular examples of horizontal motion was seen in a narrow zone along the eastern edge where the mass of material was squeezed through a constriction (figure 2). Horizontal displacement in this area was nearly 100 feet.

The effect of the slide on the park facilities was severe. The surface of the ground was greatly modified by a series of closely spaced fractures accompanied by vertical displacement of almost 6 feet. The breaking up of the ground was most apparent in the asphalt parking zones (figure 3); in the lawn areas the sod

Figure 1. Aerial view of Ecola Park showing 1961 landslide (outlined in white). Ecola Point and Sea Lion rock in right foreground.

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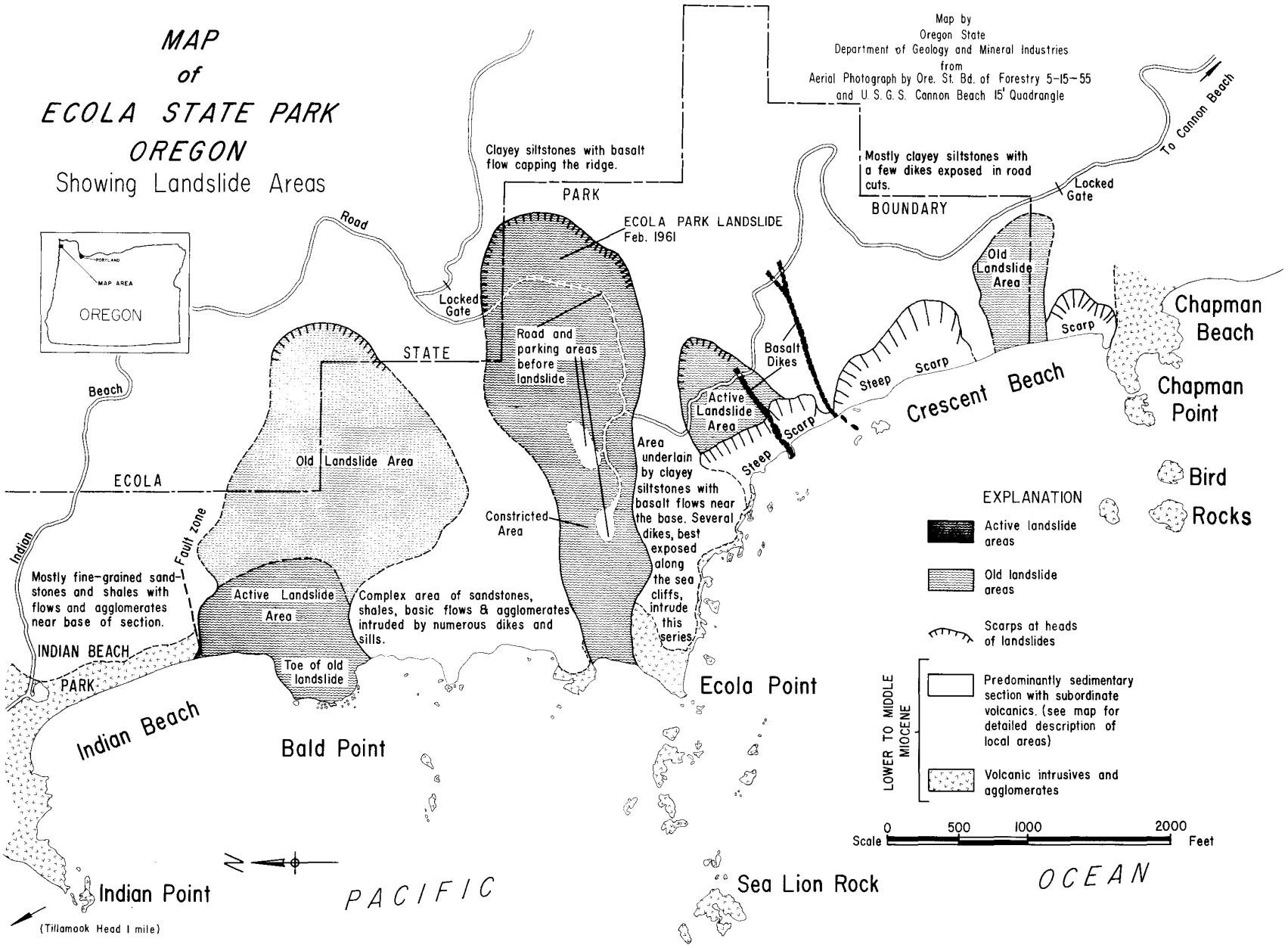
MAP
of
ECOLA STATE PARK
OREGON
Showing Landslide Areas
Map by
Oregon State
Department of Geology and Mineral Industries
from
Aerial Photograph by Ore. St. Bd. of Forestry 5-15-55
and U. S. G. S. Cannon Beach 15' Quadrangle
PORTLAND
MAP AREA
OREGON
Road
Locked Gate
Clayey siltstones with basalt flow capping the ridge.
PARK
ECOLA PARK LANDSLIDE
Feb. 1961
Mostly clayey siltstones with a few dikes exposed in road cuts.
BOUNDARY
Locked Gate
To Cannon Beach
Old Landslide Area
Scarp
Chapman Beach
Chapman Point
STATE
Road and parking areas before landslide
Basalt Dikes
Active Landslide Area
Steep
Scarp
Crescent Beach
Beach
Old Landslide Area
ECOLA
Area underlain by clayey siltstones with basalt flows near the base. Several dikes, best exposed along the sea cliffs, intrude this series.
Bird Rocks
Indian
Fault zone
Constricted Area
EXPLANATION
Active landslide areas
Old landslide areas
Scarps at heads of landslides
LOWER TO MIDDLE MIOCENE
Predominantly sedimentary section with subordinate volcanics. (see map for detailed description of local areas)
Volcanic intrusives and agglomerates
Mostly fine-grained sandstones and shales with flows and agglomerates near base of section.
Active Landslide Area
Complex area of sandstones, shales, basic flows & agglomerates intruded by numerous dikes and sills.
INDIAN BEACH
PARK
Toe of old landslide
Ecola Point
Indian Beach
Bald Point
0 500 1000 2000
Scale Feet
N
PACIFIC
OCEAN
Sea Lion Rock
Indian Point
(Tillamook Head 1 mile)

tended to stretch and pull over the smaller fractures (figure 4).

Sliding is not new to this section of the Oregon coast. Aerial photographs taken in 1939 clearly show the outline of an older slide in the park area identical to that of the recent slide. The scarp at the head of the Ecola slide today is 75 feet high, but the top 35 feet of it is covered with plant growth showing that the recent 40-foot vertical movement is a renewal of the earlier activity.

Study of aerial photographs and inspection of the ground from Chapman Point near Cannon Beach to Indian Point near Tillamook Head reveal several major landslide areas in the State Park property. These are indicated on the accompanying map. Along Crescent Beach, there are three areas of steep scarps. These earth falls are possibly related to earlier slump movements but more probably are the result of oversteepened coastal cliffs. Immediately south of the big Ecola Park slide is a smaller active area. Recent movement in this slide can be detected by fractures and displacement of the paved entrance road to the park. It is possible that this slide will continue to move.

A large area between Ecola Point and Indian Beach shows evidences of a former landslide (see accompanying map). The scarp at the head is plainly visible in the field and also shows on the 1939 aerial photographs. Recent movement appears to have been limited to the toe of the slide, but future movement is likely to involve the entire slide area much the same as at the park. So far only the trails near the toe of this slide have been damaged. Fortunately this section of the Indian Beach road is not endangered, because it traverses the area behind the head of the slide.

Landslides in Ecola State Park are essentially the result of oversteepening of unstable rocks in the sea cliffs by wave erosion. Stable volcanic rocks resist erosion and form nearly vertical headlands such as Tillamook Head, Ecola Point, and Chapman Point. But less competent sedimentary rocks, when undermined by wave erosion and further weakened by water saturation during the winter months, begin moving seaward under the force of gravity. This motion continues until equilibrium is established between the head and toe of the slide. The size and shape of the slide are dependent on a variety of conditions, such as the relative distribution of the stable and unstable rocks, the steepness of the slopes, and the amount of water saturation. Renewed movement of the slide occurs if wave erosion oversteepens the toe at a time when excessive rainfall has reduced the strength of the rock materials.

Geology of the Area

Ecola State Park is underlain by marine sediments and volcanic rocks of Tertiary age. The sedimentary strata are thin-bedded, fine- to medium-grained sandstones and silty shales that grade upward into massive fine-grained clayey siltstones. Basic flows and agglomerates are intercalated with the sediments, particularly in the lowest beds exposed along the beach. Most of the lavas are finely crystalline but appear to be basaltic in composition.

Wells and Peck (unpublished geologic map of western Oregon, in press) have mapped the sediments and flows in the Tillamook Head area as part of the Astoria formation and Columbia River basalts of middle Miocene age. Several exposures of yellowish-gray clayey siltstone along the beach below the park and also near the head of the main slide were examined for fossils. No significant megafossils were found, but foraminifera were in relative abundance. Selected samples of this material were sent to Dr. Weldon Rau, micropaleontologist for the Washington Division of Mines and Geology, for examination and identification.

One sample from a beach cut a short distance south of Ecola Point showed a diagnostic assemblage of late early Miocene to early middle Miocene age. Of this fauna Rau remarks, "The presence of good Siphogenerina branneri, together with other forms, indicates an age slightly younger than most assemblages from the Astoria formation".

Another sample from a locality approximately 1/4 mile north of Chapman Point contained

foraminifera of early Miocene age, and according to Rau, "The assemblage is quite comparable to the fauna known from the type Astoria formation".

The sedimentary rocks have been intruded by dikes and sills of basaltic rock similar in composition to the intercalated flows. The intrusive activity, which took place before the sands and silts had become completely consolidated, squeezed the sediments into a series of complex folds and small-scale faults, particularly in the zones adjacent to the intrusions. This action has undoubtedly contributed to the instability of the sedimentary rocks and made them more susceptible to landsliding. Excellent exposures of rock along the beach below the park area show the contortion of the beds and the complex relationship between the sedimentary section and the igneous intrusions (see figures 5 and 6).

Some of the dikes or sills, because of their generally resistant nature, extend out from the shore for almost a mile as a series of small basaltic islands or "stacks". Ecola and Chapman points, as well as the isolated sea stacks farther south off Cannon Beach, are examples of igneous rock that has withstood the intense erosive activity of the sea waves.

Because most of the section along the coast between Chapman Point and Bald Point has been an active slide area at one time or another, good exposures of undisturbed bedrock are relatively rare except in the beach cliffs. No attempt was made, therefore, to show details of the areal extent of any particular lithologic unit in this unstable region. Between Ecola Point and Chapman Point, sediments clearly predominate over flows or other igneous rock types. To the north, however, igneous flows, sills, breccias, and agglomerates are prominent along the sea cliffs above the beach, with the sediments mainly in the upper slopes east of the coastal strip. Tillamook Head is the center of a large igneous mass, the bulk of which appears to be a series of flows that interfinger to the south and east with a more sedimentary section.

Only one large fault was seen in the exposures along the beach. This fault zone bounds the north side of a landslide a short distance south of Indian Beach (see accompanying map). Other faults can be inferred from aerial photographs of this area, but modification of the topography by sliding has tended to obscure the structural pattern. For this reason it is difficult to determine the relationship of fault zones to landslides or how they may influence the stability of the area in general. Fault zones would probably contribute to instability where clayey sediments in the upper part of the section have been dropped down against more resistant flows and agglomerates characteristic of the lower part of the section.

Summary

Oregon, because of its rugged coastal topography, possesses one of the most scenic shorelines in the country, and many places along it make excellent homesites and recreation areas. Unfortunately some of these localities, as exemplified by Ecola Park, are susceptible to landsliding through erosion by storm waves, so that their period of use is limited.

Aerial photographs taken more than 20 years ago show that Ecola State Park is marked by numerous old slides, and the recent renewal of movement in one of these same areas proves that this will remain an unstable region for many years to come. Adjacent areas of lower topography, as at Cannon Beach, or of resistant rock, as at Tillamook Head, have been affected only by the gradual wearing back of the land.

The Oregon coast is undergoing vigorous attack by the sea, and anyone who has visited the beaches during a storm can appreciate the energy expended by wave action. At the Tillamook Rock lighthouse near Tillamook Head, waves have more than once broken the plate glass of the light 132 feet above sea level. Modification of the earth's surface by erosion is a continuing process, and along the high sea cliffs such action is particularly intensified to the detriment of homes, parks, roads, or any other feature situated nearby, especially those in areas of unstable rock.

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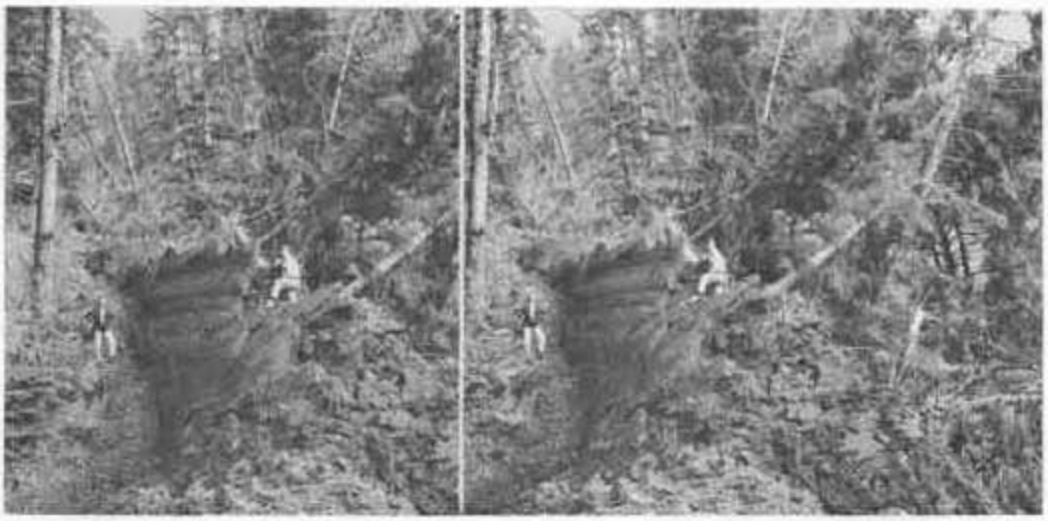

Figure 2. "Dike" of landslide material squeezed out against a buttress of more stable rock in constricted zone. Striations on wall show that direction of movement was nearly horizontal. (Use stereoscope to see third dimension).

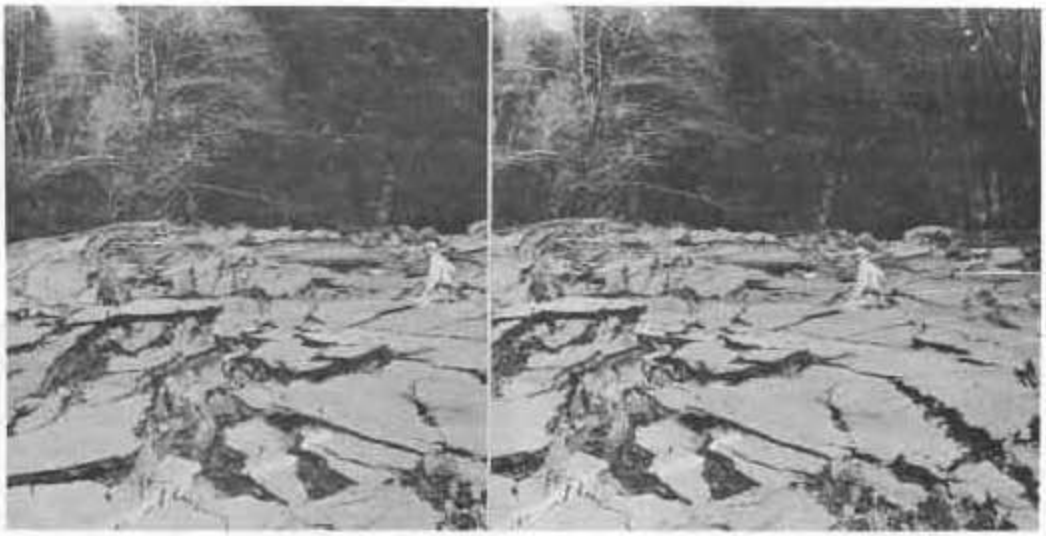

Figure 3. View of upper parking area showing broken asphalt with vertical displacement on separate blocks of as much as 4 feet. Vertical movement here was caused by upwarping and later settling of underlying sediments. (Use stereoscope to see third dimension).

Figure 4. Panoramic view of lower parking area. Vertical displacement of asphalt surface was almost 6 feet in center background. Lawn area in foreground shows only minor fracturing because turf-covered soil drapes over and obscures movement.

← Figure 5. Alternating mudstones and sandstones and overlying basaltic sill have been steeply folded. Part of deformation may be due to faulting which is obscured by slide material in valleys on either side.

Figure 6. View of sea cliff south of main slide. Bedded clayey siltstones, shales, and underlying volcanic rocks have been contorted by intrusion of basaltic dike (outlined in white). Slumping of sedimentary material on steep slopes has covered upper part of dike. →

WHITHER GOLD?*

Even though the heavy gold outflows came to an end last February, and the U.S. Treasury's gold stock has since been recovering modestly, gold continues to figure prominently in public discussions. Yet, looking through the record, one is struck by a disconcerting lack of depth in much of our thinking about gold.

The suggestion is offered--most recently by the Commission on Money and Credit--that we repeal the 25 per cent gold reserve requirement against Federal Reserve note and deposit liabilities. The idea is to free ourselves of the rigidity of a fixed reserve, and to show the world that our entire $17.5 billion gold stock is available, if necessary, to defend the price of $35 an ounce. This proposal has a good measure of support; it would no doubt be many years before Fort Knox could be totally emptied. But what then?

The proposal raises more questions than it answers. We should know where we are heading and where we want to come out. Would we expect foreign government officials, bankers, and businessmen to believe that all our gold would be allowed to go out to maintain the $35 price? Or do we wish to put ourselves in the posture of wanting to get rid of gold, thus making the dollar a straight-out credit or fiat money? Could the dollar as a currency and the United States as a nation maintain their world prestige if other countries were the sole possessors of the precious metal? Or would it be contemplated that other nations, too, would give up their official gold reserves and make gold a simple commodity, traded in free markets?

It is only by facing up to issues like these that we can arrive at intelligent policies. We have the problem of defining the proper place for gold in our monetary set-up as well as in the world currency system.

Monetary Status Today

The United States abandoned the gold standard in 1933 and, since the enactment of the Gold Reserve Act in January 1934, has been on what has been called an international gold bullion standard. The differences between the full gold standard and our present gold arrangements stand out clearly in the table.

Full Gold Standard and Present U.S. Gold Arrangements Compared

Full Gold Standard	Present U.S. System
Monetary unit defined by law in terms of specific weights of gold.	The dollar defined as a specific weight of gold by Presidential proclamation under the Gold Reserve Act of 1934.
Currency freely redeemable in gold coins or bullion.	No gold coins coined; no U.S. currency redeemable in gold; private holding of gold unlawful.*
Free buying and selling of gold at a fixed price.	Purchases and sales at a fixed price, with sales limited to foreign monetary authorities for "legitimate monetary purposes" and to licensed domestic dealers for approved purposes.
Free gold export and import.	Free import of gold; export of gold subject to license.
Gold--legal tender for payment of debt.	All coins and currencies of the United States declared legal tender.
Gold cover for domestic currency.	Legal gold reserve requirement of 25% of Federal Reserve note and deposit liabilities.

*Except for gold in its natural state and gold coins of recognized value to collectors.

The present monetary status of gold is thus a hybrid one. The dollar is defined in law as a quantity of gold, but no dollars of the present weight of gold have ever been coined and U.S. currency is irredeemable in gold. Yet, at the same time, the U.S. dollar is linked to gold in the sense that the Treasury buys and sells gold at the statutory price of $35 an ounce in transactions with foreign central banks and governments "for legitimate monetary purposes." These words have never been defined officially, but they were interpreted quite broadly in late 1960, following the flare-up in the London gold price, when the United States supplied gold through the Bank of England to private holders at a price in excess of $35 in order to counter speculation that the dollar might be devalued.

The U.S. Treasury has no commitment to buy or sell gold; the present practice could, therefore, be changed without notice. But if the U.S. Treasury were to stop selling gold to foreign central banks at the official price, or buying gold from them, gold would be free to fluctuate in terms of the dollar, and foreign exchange markets of the Free World would be thrown into confusion until U.S. intentions were clarified.

No other country patterns its gold policy on that of the United States. We alone give fixed-price gold convertibility--though only to foreign monetary authorities. On the other hand, we suppress private holding and trading, while nations abroad permit or even encourage free markets. Of these, the London market, reopened in 1954 after sixteen years, is the most important.

The United Kingdom forbids its citizens to hold or trade in gold, only nonresidents of sterling-area countries are allowed to buy gold in the London market--in effect against U.S. dollars. More commonly, however, free gold markets are conducted in local currencies; as in England, the monetary authorities participate. Only a few countries--including Germany and Switzerland--allow their nationals to export gold freely. A number of countries mint gold for

*Reprinted from First National City Bank Monthly Letter, August, 1961. Section on European views concerning gold has been omitted.

sale in free markets. But no country has fixed prices for gold coins. None is on a gold coin standard. The last nation that could be so classified was Saudi Arabia, and the coin of the realm was the sovereign.

Less than half of the central banks in the world have--like the Federal Reserve System--legal gold (or gold and foreign exchange) requirements against their note issues and deposit liabilities. In many countries, including the United Kingdom, these requirements have been repealed or suspended, usually at times of national emergency; a number of central banks established since World War II, including the German Bundesbank, have no such requirements.

Cutting Loose From Gold

It is against this background that the recommendation of the Commission on Money and Credit to repeal the gold reserve requirement "as an archaic instrument of monetary control" should be considered. The law requires the Federal Reserve Banks to keep gold certificates equal to at least 25 percent of their note and deposit liabilities. (The gold certificates are issued by the Treasury which has actual physical custody of the metal.) On this formula, the required gold cover works out to something over $11 billion, as against the U.S. stock of $17.5 billion. This leaves some $6.5 billion in excess gold reserves--approximately $3.5 billion less than our short-term liabilities to official foreign institutions, which are eligible for conversion into gold. Our short-term liabilities to private foreign holders stand at $7 billion; these are not eligible for conversion unless sold to a central bank.

The idea is to make all of our gold available to cover short-term liabilities to foreigners, including those that may accrue in the future. Actually, the gold is already available since present legislation permits temporary suspension, with penalties, of the gold reserve requirement in case of need. But the Commission believes that:

"...threat of a confidence crisis would be greatly reduced if it were regenerally recognized, both here and abroad, that all of the U.S. gold is available to meet our international obligations. Any doubts about the U.S. policy should be removed by elimination of the gold reserve requirement at the earliest convenient moment so that all of the U.S. gold stock is available for international settlements."

Arguments like these are persuasive. A "reserve", in the truest sense, should be available to meet emergencies. Another appealing point is that, since the dollar is no longer convertible into gold except for transactions with foreign governments and central banks, the need for a specific domestic currency cover is outdated.

Missing from the Commission's report, however, is any consideration of the need of the United States, with its far-flung international commitments and its position at the center of the monetary universe, for a gold reserve. Is it realistic to expect that, even with all our productive power to give real value to money, the U.S. dollar could command full respect under all circumstances? Unless gold is demonetized by international agreement--something that does not appear to be in the cards--the United States needs a gold reserve commensurate with its economic and financial strength and responsibilities. It also needs gold for use in emergencies; as a matter of fact, Russia attaches vital importance to gold as a war chest.

Granted this, it follows that we must form some conception of the levels below which the U.S. gold stock should not be allowed to fall. The British seem to have in mind something of this sort: for example, a decline in British reserves below £1,000 million at the end of June tripped off an emergency program announced by the Chancellor of the Exchequer on July 25 to defend the pound.

We must incorporate into our thinking on this question a clearer recognition of the need and function of a gold reserve, and emphasize more strongly the necessity of accepting the disciplines required to maintain it. What the minimum reserve requirements might be, and whether determination of the minimum should be incorporated in law, are arguable questions, but it is indisputable that protection of the gold reserve should be an objective of public actions and policies.

As the centerpiece of the international monetary structure, the dollar needs an especially strong reserve. Perhaps 40 to 50 per cent of our overseas liabilities should be construed as something of a danger point. The $11 billion required gold cover under present law works out to somewhat over 50 per cent of gross overseas liabilities. Thus, by accident if not design, it affords a reasonable conception of a level at which we should be awakened to a sense of crisis and need to take stern measures to retain for the dollar its place as an anchor of monetary stability. This is not to suggest either that in a time of gold losses corrective actions and policies can safely be deferred until this level is reached--that lesson was learned in 1960--or that we should take the occasion of a decline in reserves to this point as a reason for suspending gold payments or devaluing the dollar.

It may also be asked whether there is a point at which retaining a minimum gold reserve could become more important than keeping the $35 selling price. Assuredly, it would make no sense to let all the gold go out and then to raise the bid price to recoup some of the loss. The way to avoid a devaluation of the dollar is, of course, to deal effectively with the hard core of our balance-of-payments difficulties, along lines often discussed in these pages. The real question is whether policies necessary to maintain financial stability would be implemented as promptly, as courageously, and as effectively if we were to eliminate the gold requirement as if we kept it. The requirement, as W. Randolph Burgess once said, is like a "red light"--a warning to hold inflation in check and keep spending abroad to what we can afford.

The Role of Gold

Gold has won its place in the world today as, over many centuries, man has groped toward workable ways to facilitate trade

and store value through the use of money. Commodity money grew out of bartering; gold (and silver) coins became convenient media of exchange and stores of value; promises to pay gold became the most convenient means of payment; and nations, departing from the full-fledged gold standard, embarked upon monetary "management." But "management" did not always show itself as vigilant, skillful, and courageous as was necessary to ensure monetary stability at home and to enable the international monetary system to function properly.

There is no way to turn the clock back. By the same token, however, there is no practical possibility of cutting loose from gold altogether. There are times and circumstances when no other "money" is acceptable. Recognition of this helps reinforce monetary discipline--something we must have if we want an orderly society.

Gold guards against reckless budgetary and monetary practices by making it necessary for a country--whether or not it has a prescribed gold cover for its currency--to frame its domestic economic and financial plans and policies with continuing regard to the external influences to which it is subject, as well as to the external repercussions of its own acts. Now that many currencies of Western Europe rank as good as the dollar, we are confronted with a healthy challenge to keep the dollar as the key reserve currency. The dollar and the gold reserve will take care of themselves if we restrain inflationary pressures, compete successfully in world markets, and measure government commitments abroad against what we can, by trade and judicious investment, earn overseas.

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STANDARD OIL APPLIES FOR EXPLORATION PERMIT

The Standard Oil Co. of California applied for a permit to do seismic work off the Oregon coast on September 1, 1961. This brings the total to four companies that have obtained offshore exploration permits, as follows:

Company	Type Survey	Exploration Period Applied For
Shell Oil Co.	Seismic - explosive	6-13-61 to 12-31-61
Gulf Oil Corp.	Seismic - gas exploder and sparker	6-15-61 to 12-31-61
Union Oil Co.	Seismic - gas exploder	7-10-61 to 11-10-61
Standard Oil Co.	Seismic - gas exploder	9-1-61 to 8-31-62

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PROPOSED LAND WITHDRAWALS

Two applications for withdrawal of lands from all forms of appropriation under the general mining laws were filed recently with the Bureau of Land Management, Portland, as follows:

The U. S. Forest Service applied August 9 for withdrawal of 4,872 acres in the Ochoco National Forest, Crook County, for the purpose of consolidating national forest land for administrative purposes.

The Bonneville Power Administration filed September 15 for withdrawal of about 10 acres in sec. 13, T. 21 S., R. 19 E., Deschutes County, to construct the Hampton substation and facilities for service to the Central Electric Cooperative.

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HISTORY OF THE BONANZA MINE

Oregon's largest and most productive quicksilver mine, the Bonanza, situated about 7 miles east of Sutherlin in Douglas County, was closed in October 1960. During the current year mining and reduction equipment has been dismantled and the property offered for sale. The mine had been in almost continuous operation since 1937 and had produced more than 39,000 flasks to account for about 38% of Oregon's total quicksilver production. Although the eventual depletion of minable reserves of any quicksilver mine must be considered inevitable, closure of the Bonanza mine was like the passing of an old friend to the mining people of the West.

The history of the Bonanza mine dates back to the early days of mining in Oregon. Cinnabar is said to have been discovered there some time during the 1860's. Some of the early development was done by the Bonanza Quicksilver Mining Co., which was organized in 1878. This company reportedly installed the Scott furnace, parts of which are still on the property. Following these activities, the property passed through the hands of several individuals and groups, none of which succeeded in putting the mine on a paying basis.

Most of the early operations were confined to float and surface ore mined from a glory hole in the outcrop of the north or main ore body and from several short adits all less than 250 feet long. In 1935 the mine was acquired by H. C. Wilmot, who organized Bonanza Mines, Inc. (renamed Bonanza Oil & Mines Corp. in 1951), and development of a small ore body that lay several hundred feet to the south was started. A 5-deck Herreshoff furnace of 50-tons-per-day capacity was installed and in late 1937 production began.

Continued underground exploration led to the discovery of "good" ore in the north hill in 1939 just as the south ore body was playing out. As a result, two 100-ton-per-day Gould rotary furnaces were added to the treatment plant. Discovery and development of the rich ore body had come at a period when war time demands were forcing quicksilver prices to record highs, and for the year 1940 the Bonanza mine ranked second among the quicksilver producers in the United States with a production of 5733 flasks. The Bonanza mine was the only major quicksilver mine in Oregon to continue operations through the war years. One of the rotaries was dismantled and moved to the company's property at Hermes, Idaho, in the summer of 1942. For several years prior to closure of the mine only the remaining rotary furnace had been in use.

The ore bodies at the Bonanza mine occurred as irregular lenses scattered along a shear zone in Eocene sandstone beneath a layer of relatively impervious shale. The shear zone, having an average dip of about 45°, approximately parallels the bedding in the sandstone, but in some places transects it, particularly at points where flexures in the latter occur. Localization of the mineralizing solutions within the shear zone is thought to have been aided considerably by the imperviousness of the overlying shale. For much of its length the shear zone was found to be thin and indistinct but locally and unpredictably it widened to form lens-shaped zones which contained the ore bodies.

Where first encountered on the 370 or main haulage level, the principal ore body of the mine proved to be about 600 feet long and as much as 60 feet thick. Because of a gradual tapering of the ore body to a width of about 4 feet and a length of 150 feet on the 700 foot level, it was feared in 1944 that mining below the 700 foot level would prove unprofitable. Fortunately nodal extensions and subsidiary lenses of good ore were encountered along the shear zone materially lengthening the life of the mine. Ore has been mined from the surface to an inclined depth of about 1450 feet. Economical recovery of ore from the 1450 foot level, the last to be developed, proved impossible under present conditions.

- Howard Brooks, Field Geologist, Baker Office

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