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Nevada oil shale was first recognized at Elko in 1875 by R. M. Catlin (Russell, 1980, p. 75), and there were some attempts at about that same time (before the character of oil shales was recognized) to utilize some of the darker shales as coal for the railroad (Winchester, 1923, p. 101). The Elko oil shales were described in the early geological reports on the area by the U.S. Geological Survey. Although he did not refer to the rocks as oil shale, Clarence King (1878, p. 312) described brown carbonaceous beds north of Elko as "containing a high proportion of volatile hydrocarbons burning when heated with an intensely blue flame ... ."

The term oil shale was first used in the Nevada geologic literature by Schrader and others (1916), who reported oil shale outcrops near Elko and at Hamilton west of Ely. Lincoln (1923) briefly mentioned five other Nevada localities. Several of these localities have had no further geologic investigation to date (for example, the locations queried on fig. 1).

The Catlin Shale Products Company plant at Elko, operated intermittently between 1917 and 1924, was the best technically oriented and best financed effort to develop western U.S. oil shales during this period (Russell, 1980, p. 75). Although over 12,000 barrels of shale oil were probably produced, the plant was a commercial failure and the shale oil products were generally of poor quality. The Catlin operation was a pioneer effort in the U.S. to develop methods to produce shale oil for competition with petroleum products (Russell, 1980, p. 75).

Except for the Elko shales, no other attempts have been made to exploit any of the State's scattered oil shales. Although several oil shale localities in Nevada have been known for some time, only recently have investigators begun

to survey certain geologic units for their potential to produce synthetic crude oil (syncrude). Little is known about oil shales at some individual obscure localities, or about their presence beneath Quaternary and late Tertiary sediments in unexplored basins. Figure 1 shows only outcrop areas of oil shales and related rocks (including low-grade material and recent and Quaternary organic mucks); similar rocks are also believed present in down-faulted blocks of adjacent valley areas.

Nevada's known oil shale deposits are almost entirely in either Cretaceous to early Tertiary lacustrine rocks or Paleozoic marine dark shales. The Elko Formation in northeastern Nevada contains the majority of oil shales in Nevada that have potential for commercial exploitation, but even these shales may not be exploited in the forseeable future (Moore and others, 1983).

Oil Shale in Lacustrine Rocks

Tertiary oil shales in Nevada are known to occur in Early Cretaceous to earliest Oligocene lacustrine rocks in eastern and northeastern Nevada; the kerogen in these rocks was probably derived from the lipid fraction of algae. The major deposits are similar in age and lithology to the Green River Formation of Utah and Colorado.

The well-known oil shales of the Elko Formation crop out in several areas in northeastern Nevada and probably underlie many valley areas (Ketner, 1970, p. B108). Syncrude yields of over 70 gal/ton have been reported from high-grade samples (for example, see Smith and Ketner, 1976, p. 22). The oil shales in the vicinity of Elko have been studied in the most detail (see Solomon, 1981 and Solomon and others, 1979). In the Elko area, Moore and others (1983) estimate that the total in-place shale oil (syncrude) is 600 million barrels. Of this total, 228 million barrels are from beds that average at least 15 gal/ton over a 15-foot thickness, the remaining 373 million barrels represent low-grade shale that averages only 5 gal/ton over a thickness of 260-280 feet. Figure 2

shows a representative section of a part of the formation exposed north of Elko.

The Sheep Pass Formation, which is present in White Pine and northeastern Nye Counties (both as exposures in the mountain ranges, fig. 1, and probably in the subsurface in many valleys), has long been known to contain oil shales (Lincoln, 1923, p. 39, 166). The age of the unit ranges from Late Cretaceous to Eocene (Fouch and others, 1979). The pyrolytic oil yield of lipid-rich units of the Sheep Pass Formation has only been reported for a few localities. Fouch (1977) reported that a significant thickness of Sheep Pass present in the subsurface in Railroad Valley (northern Nye County) contains in excess of 4 gal/ton of shale oil; he also reported a yield of over 8 gal/ton for one sample from the unit. No reserve or resource estimates have been made on the Sheep Pass oil shales, but many of these are probably quite low grade.

The Early Cretaceous Newark Canyon Formation at its type section in southeastern Eureka County contains several meters of lipid-rich oil shale that has a pyrolitic yield of over 10 gal/ton (Fouch and others, 1979). The unit is believed to contain oil-shale units elsewhere in the vicinity, but no information is available.

Oil Shale in Marine Dark Shales

The organic-rich marine rocks in Nevada that have been identified as capable of yielding appreciable quantities (10-33 gal/ton; Poole and Desborough, 1980) of syncrude upon destructive distillation are Paleozoic eugeosynclinal deposits. They probably owe their organic content to the upwelling of nutrient-rich waters in a deep-water continental rise environment. There are other Nevada black shales, including trough and platform depositional types, which may locally yield oil on pyrolysis (for example, the Mississippian Chainman Shale and the Permian Phorphoria Formation). However, in many cases these rocks contain mostly nonvolatile organic matter.

The Ordovician Vinini Formation has consistently shown interesting oil yields from surface samples, but there is only limited information available. Nolan and others (1956, p. 35) reported that selected samples from the Vinini at several localities in the Roberts Mountains of central Eureka County yield over 25 gal/ton. Although the Vinini is a widespread unit in Nevada, only a few localities have been studied for their oil shale potential.

The Devonian Woodruff Formation in the Fish Creek Range of southeastern Eureka County yields up to 12 gal/ton of syncrude oil (Desborough and others, 1979). In addition, the shales are enriched in several metals (V, Zn, Mo, Se, Ag), and may constitute a resource for these elements as well as for syncrude (Poole and Desborough, 1980).

Organic-Rich Quaternary Sediments

Highly organic sediments of the Quaternary Wyemaha Formation occur in the shallow subsurface and at the surface in the Carson Desert, a playa lake area east of Fallon (fig. 1). Shallow water wells, generally about 300 feet deep, often produce methane from these organic-rich sediments (Morrison, 1964). An exploratory oil well in another part of the playa (the eastern Carson Sink) penetrated a series of highly organic lacustrine clays and silts of Quaternary age from the surface to 6895 feet. Free oil was found in vugs in an underlying basalt (Hastings, 1979). Morrison (1964) reported that tests for the presence of petroleum in the organic-rich sediments by carbon tetrachloride extraction were negative.

Young, organic-rich sediments are probably also present in other playa deposits, which are extensive in Nevada. For example, they were encountered in shallow drill holes on the playa at Columbus Salt Marsh in northwest Esmeralda County (Keith Papke, oral commun., 1983). The organic matter is probably derived from algae and may be a precursor of kerogen. No studies have been done

on the amount of shale oil the sediments might yield on destructive distillation. In any case, they contain so much water that they are probably not an economic source of shale oil. These young organic-rich sediments deserve further study for clues to the origin and preservation of organic matter in oil shales.

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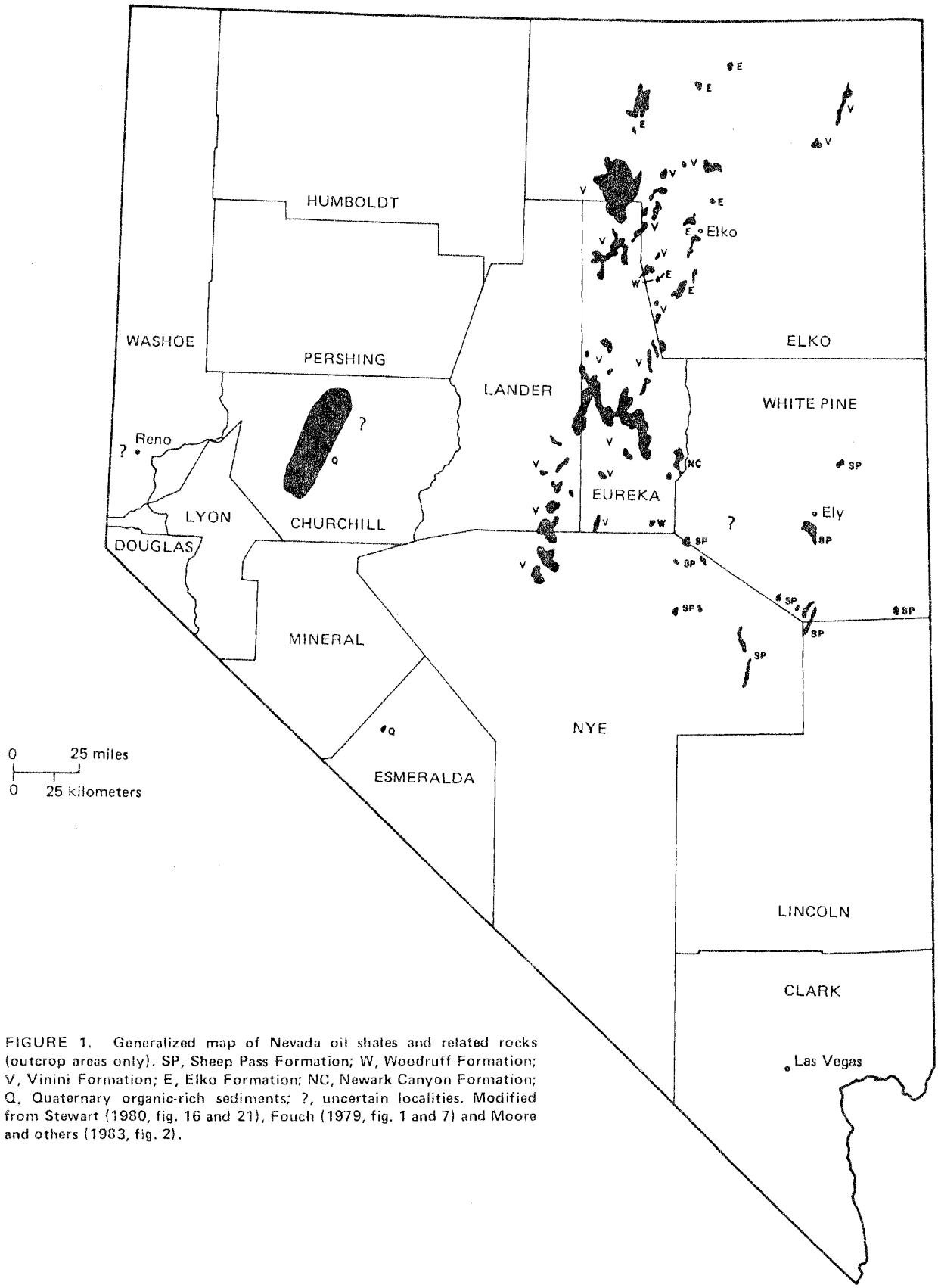

FIGURE 1. Generalized map of Nevada oil shales and related rocks (outcrop areas only). SP, Sheep Pass Formation; W, Woodruff Formation; V, Vinini Formation; E, Elko Formation; NC, Newark Canyon Formation; Q, Quaternary organic-rich sediments; ?, uncertain localities. Modified from Stewart (1980, fig. 16 and 21), Fouch (1979, fig. 1 and 7) and Moore and others (1983, fig. 2).

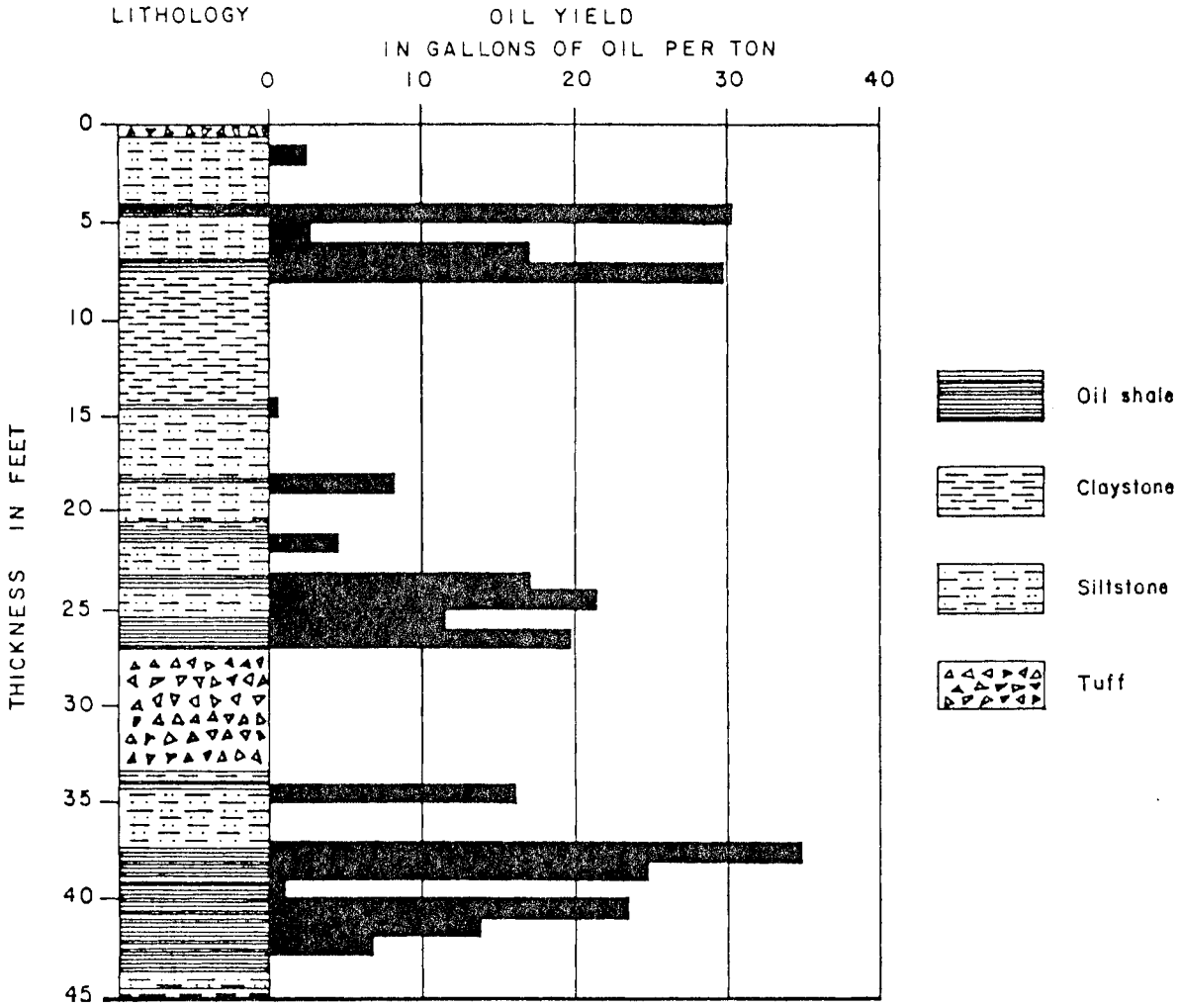

FIGURE 2. Oil yield and lithology of the oil shale member of the Elko Formation in trench COS-3, Elko West quadrangle, Nevada (from Solomon and Moore, 1982).