DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH
THE U.S. DEPARTMENT OF ENERGY

MISCELLANEOUS FIELD STUDIES
MAP MF-1890

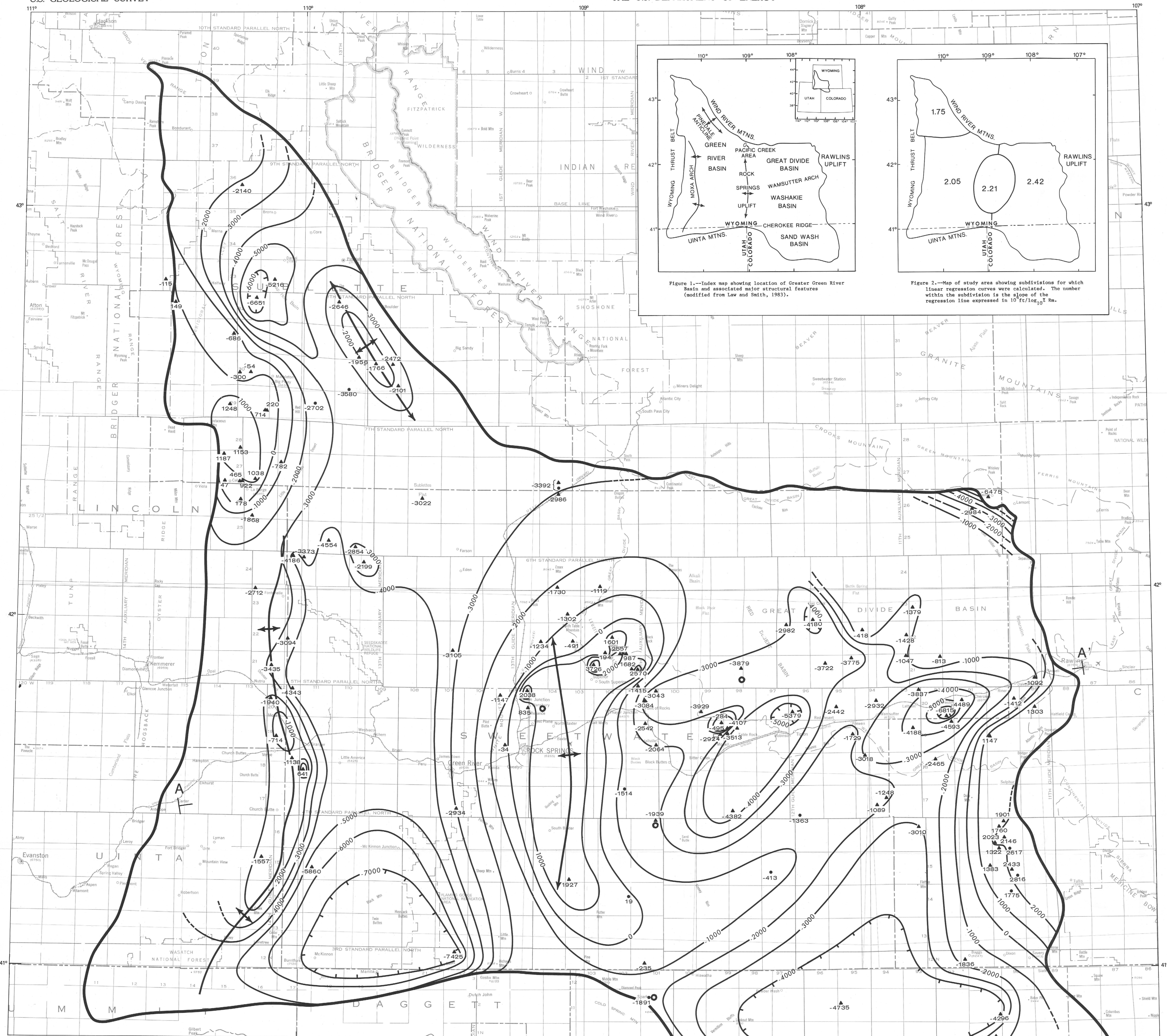

Figure 1.--Index map showing location of Greater Green River Basin and associated major structural features (modified from Law and Smith, 1983).

Figure 2.--Map of study area showing subdivisions for which linear regression curves were calculated. The number within the subdivision is the slope of the regression line expressed in 10^4 ft/$\log_{10}$% Rm.

INTRODUCTION

Large gas accumulations are contained in low-permeability reservoir rocks of Late Cretaceous and early Tertiary age in the Greater Green River Basin of Wyoming, Colorado, and Utah (fig. 1). The vertical and horizontal limits of these gas-bearing reservoirs have been described by Law and others (1980), Spencer (1983), and Law (1984). These reports have shown that the gas-bearing rocks are coincident with abnormally high formation pressures (overpressuring) and that the top of overpressuring occurs at a vitrinite reflectance (R_m, mean random vitrinite reflectance) value of about 0.8 percent. Thus, the primary purpose of this study is to provide a thermal maturity map of the Greater Green River Basin showing the subsurface elevation of 0.8 percent R_m. Although thermal maturity studies are most often utilized in investigations of hydrocarbon generation, preservation, and migration, they also provide important information regarding the thermal and burial history of sedimentary basins, such as the studies in the northern part of the Greater Green River Basin by Lickus and others (1984), Naeser (1984), and Pollastro and Barker (1984).

METHODS

413 core and cuttings samples of coal, shale, siltstone, and sandstone were collected from 134 wells in the basin. The number of samples per well ranged from 1 to 47. Vitrinite reflectance measurements of coal and kerogen were determined using reflected light under oil immersion. The kerogen from the noncoal lithologies was extracted by an acid maceration technique (King and others, 1963; Saxby, 1970). The maceration process, for the most part, yielded good results and the data obtained from the analyses are considered reliable. Coal samples and thin organic-matter-rich laminae were not processed with the acid maceration technique.

Owing to the wide geographic and stratigraphic distribution of the samples, the basin was subdivided into four areas (fig. 2). Within each area, a linear regression plot of depth (in feet) versus $\log_{10}$% R_m (fig. 3) was constructed, and the slope of the least squares regression line determined. In wells containing less than five samples distributed over a thin stratigraphic interval, subsurface elevations of 0.8 percent R_m were calculated using the appropriate slope obtained from the linear regression plot. In wells containing five or more samples distributed over a thick stratigraphic interval, subsurface elevations of 0.8 percent R_m were calculated by constructing a separate linear regression plot for each well. Data from four wells were not used because the R_m histograms were widely scattered and the calculated depths differed significantly from surrounding wells. The contours were hand drawn and were largely influenced by structure, especially in areas where the data were sparse.

DISCUSSION

Law (1984) has shown that gas generation and occurrence in the Greater Green River Basin is related to organic richness, subsurface temperature, overpressuring, and thermal maturity. Therefore, the thermal maturity map would be best utilized in conjunction with other information such as the subsurface temperature map of the Greater Green River Basin by Law and Smith (1983).

Cross section A-A' (fig. 4), from the Church Buttes gas field in the southwestern part of the basin east to the Rawlins uplift, illustrates the general relationship of the 0.8 percent R_m isoreflectance line to the basin structure. Along the cross section, from the east flank of the Moxa arch over to the Rock Springs uplift, and in the eastern part of the cross section, the dip of the isoreflectance line is generally less than, or equal to the structural dip. Stach and others (p. 43-46) (1975), and Bustin and others (1983) have suggested that the degree to which isorank (here isoreflectance) lines conform to structure provides information on the temporal relationships between thermal maturation and structural deformation. This line of reasoning would suggest that in these areas the development of thermal maturation was contemporaneous with structural deformation.

However, recent work by Law and others (1986) in the area of the Patrick Draw oil and gas field provides an alternative explanation. They suggest that the abnormally high level of thermal maturity in the Patrick Draw area is due to thermal alteration of organic matter by relatively hot fluids migrating upward along fault planes and (or) fracture systems. The timing of such a heating event may be independent of deformation and may occur at any time during the burial history of the affected rocks. Therefore, the conventional way of determining the relative timing of thermal maturation may be misleading in this area.

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Base from U.S. Geological Survey State base map, Colorado, 1968; Utah, 1958; Wyoming, 1964

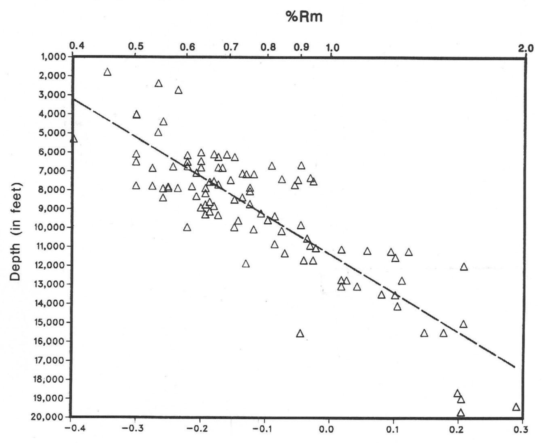

Figure 3.--Sample regression plot showing data from the western Green River Basin area plotted on a graph of depth (in feet) versus $\log_{10}$% R_m. Dashed line is least squares linear regression line.

EXPLANATION

CONTOUR--showing elevation in feet above mean sea level of 0.8 percent R_m. Dashed where approximate. Hachures show closed depressions. Contour interval 1,000 ft

ANTICLINE--Showing direction of plunge

WELL LOCATION AND CALCULATED ELEVATION OF 0.8% R_m

WELL FROM WHICH % R_m WAS MEASURED FROM CORE

WELL FROM WHICH % R_m WAS MEASURED FROM CUTTINGS

WELL FROM WHICH % R_m DATA WERE AVAILABLE BUT NOT USED IN COMPILATION

SCALE 1:500 000

10 0 10 20 30 40 50 MILES

10 0 10 20 30 40 50 KILOMETERS

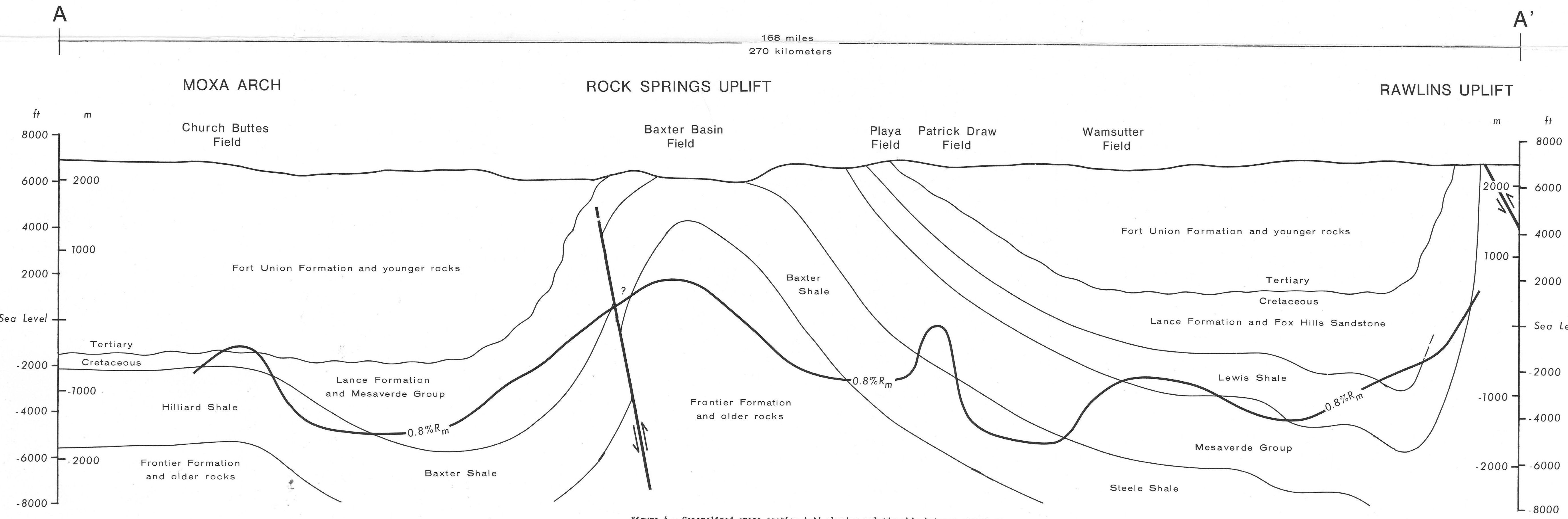

Figure 4.--Generalized cross section A-A' showing relationship between structure and 0.8 percent R_m line. Heavy line indicates 0.8 percent R_m, queried where uncertain; arrows indicate direction of relative motion along faults; irregular line indicates Tertiary-Cretaceous unconformity.

THERMAL MATURITY MAP SHOWING SUBSURFACE ELEVATION OF 0.8 PERCENT VITRINITE REFLECTANCE IN THE GREATER GREEN RIVER BASIN OF WYOMING, COLORADO, AND UTAH

By

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