STRATIGRAPHIC AND TIME-STRATIGRAPHIC CROSS SECTIONS: A NORTH-SOUTH TRANSECT FROM NEAR THE UINTA MOUNTAIN AXIS ACROSS THE BASIN AND RANGE TRANSITION ZONE TO THE WESTERN MARGIN OF THE SAN RAFAEL SWELL, UTAH

By

Douglas A. Sprinkel

INTRODUCTION

The U.S. Geological Survey is conducting multidisciplinary geologic studies of several sedimentary basins in the United States under the auspices of the U.S. Geological Survey's Evolution of Sedimentary Basins Program. This report is the Utah Geological Survey's contribution to the study of the Uinta-Piceance Basin.

These cross sections incorporate published stratigraphic information and reinterpret data obtained from selected exploration boreholes to illustrate the stratigraphic relationships of rocks in an area that extends south of the Crawford Mountains, across the western projection of the Uinta Mountains and Uinta Basin, and across the San Pitch Mountains and Wasatch Plateau to the northwest side of the San Rafael Swell (figs. 1 and 2). Johnson and Johnson (1991a, 1991b), and Franczyk (1991) published cross sections of rocks in other parts of the Uinta-Piceance Basin area.

The purpose of these cross sections is to illustrate the changes in lithofacies, thickness, and nomenclature of Phanerozoic stratigraphic units from a north-south perspective. None of the stratigraphic units were palinspastically restored for the cross sections.

CONSTRUCTION OF THE STRATIGRAPHIC CROSS SECTIONS

DISCUSSION OF THE DATA POINTS

The cross sections were constructed using 31 data points consisting of 29 exploratory wells and two surface-control points (table 1, appendix). The wells were selected because of their location, depth of penetration, and amount of stratigraphic section preserved in the well. Published geologic maps and stratigraphic reports were used to augment subsurface control and determine the regional extent, thickness, and nomenclature of stratigraphic units. The depths of individual wells used in these sections range from 1,088 ft (332 m) to 21,845 ft (6,658 m).

Gamma ray, sonic, formation-density-compensated neutron, and resistivity logs were used to determine subsurface contacts or formation tops, and to correlate stratigraphic units. For some wells (mostly wells in Utah, Juab and Sanpete counties), mud logs were available to aid in lithologic identification of stratigraphic units; the sonic-density and neutron-density cross-plot methods (Schlumberger, 1972, 1984) were used to determine the lithologies of critical stratigraphic intervals. No cuttings or cores from the wells within the study area were examined.

DISCUSSION OF THE TIME-STRATIGRAPHIC CROSS SECTION

The time scale of Haq and Van Eysinga (1987) was used to construct the time-stratigraphic cross section, and the stratigraphic units are shown in their best fit. The section line crosses or parallels many significant geologic features, such as the Sevier orogenic belt (Armstrong, 1968), areas of diapirism (Witkind, 1982), and the Utah hingeline (Stokes, 1976) (figs. 3 and 4). These geologic features produced rapid lithofacies changes between closely spaced wells or juxtaposed depositional facies within a borehole, creating special problems for construction of the sections.

The time-stratigraphic relationships within the Charleston-Nebo thrust plate (data points 8–11, 13, and 14) proved the most difficult to represent because several thrust faults were found in some wells. The most significant thrust fault was penetrated by the Placid Oil Company Daniels Land #1 well (data point 8). In that well, the Charleston thrust fault placed allochthonous strata (represented by thicker depositional facies of the Upper Mississippian to Middle Pennsylvanian Manning Canyon Shale and Lower Pennsylvanian to Lower Permian Oquirrh Formation) over autochthonous strata (represented by Mesozoic strata and thinner depositional facies of the Middle Pennsylvanian to Lower Permian Weber Sandstone).

To graphically represent the stratigraphic relationships within the Charleston-Nebo thrust plate on the time-stratigraphic cross section, a solid line with barbs marks the thrust-fault boundary at the base of the allochthon. A dashed line with barbs marks the thrust-fault boundary at the top of the footwall. Solid time lines are used to indicate the allochthonous strata found within the allochthon and the autochthonous strata found below the allochthon. Autochthonous strata found between the thrust-fault boundaries are indicated by dashed time lines. No special graphic representation was needed to portray repeated stratigraphic units found in wells located within the zone of imbricate thrust faults and post-thrusting diapirism (data points 15–25).

DISCUSSION OF THE STRATIGRAPHIC CROSS SECTION

The datum for the stratigraphic cross section is the J–2 unconformity (Pipiringos and O'Sullivan, 1978) at the top of the Gypsum Spring Member of the Twin Creek Limestone. Where the Gypsum Spring Member of the Twin Creek Limestone is not preserved, the J–2 unconformity truncates the J–1 unconformity and is located at the top of the Nugget Sandstone and Navajo Sandstone (Pipiringos and O'Sullivan, 1978). Most wells used to construct the cross section penetrate the J–2 unconformity. The unconformity at the base of the North Horn Formation was arbitrarily used as a local datum for part of the Charleston-Nebo thrust plate (data points 9–11).

The thicknesses of stratigraphic units were determined from geophysical well logs and nearby outcrops. The reader should be aware that for some units (particularly Upper Cretaceous and Tertiary units in the Wasatch Plateau area) the thicknesses determined from well logs may disagree with nearby outcrop data. The thicknesses of stratigraphic units that were not penetrated by the wells or whose contacts were undeterminable from well logs were extrapolated between data points and constrained by regional data. The erratic variations in thickness of some units were regarded as duplication or attenuation of stratigraphic section attributable to structural mechanisms. Where stratigraphic units are repeated within a well, an average thickness was used in the cross section. Normal thickness variations result from regional changes in depositional patterns. Thicknesses of units determined from well logs are summarized in tables 2 through 5. The thicknesses of units listed in the Appendix are considered to be apparent stratigraphic thicknesses because no dipmeter data were found for the wells used in the study to calculate true thicknesses.

DISCUSSION OF STRATIGRAPHIC PROBLEMS AND INTERPRETATIONS

The following section briefly describes the problems encountered and interpretations used during the construction of these cross sections. Some of the stratigraphic units are discussed in regional terms, but this report does not cover the entire Phanerozoic history or the paleogeographic settings of these rocks.

CAMBRIAN STRATIGRAPHY

Lochman-Balk (1972, 1976) shows that the basal Cambrian quartzite units were time-transgressive from Early Cambrian in the west to Late Cambrian in the east, unconformably onlapping Precambrian strata. The section line for this report generally parallels the time-transgressive shoreline where the basal Cambrian rocks are thought to be mostly Middle Cambrian.

Overlying Cambrian strata can be divided into a thinner eastern depositional facies (data points 26–31) and a thicker western depositional facies (data points 15–25) in central Utah (Juab, Sanpete, and Emery counties). The thinner depositional facies consists of the Ophir Shale and Maxfield Limestone (Middle Cambrian), and Lynch Dolomite (Upper Cambrian)(Hintze, 1988). The thicker depositional facies consists of the Teutonic Limestone, Dagmar Dolomite, Bluebird Dolomite, and Cole Canyon Dolomite (Middle Cambrian), and the Opex Formation and Ajax Dolomite (Upper Cambrian)(Hintze, 1988). The location where the Cambrian strata thickens is not well known, but it is probably somewhere within the zone of Cretaceous imbricate thrusting and post-thrust diapirism (data points 15–25). Elsewhere along the section line, the thinner depositional facies of the Middle and Upper Cambrian units are the dominant rock types.

A regional unconformity marks the top of the Cambrian strata. The Maxfield Limestone and Lynch Dolomite are not preserved (Bromfield and others, 1970) along the western projection of the Uinta Mountains (data point 7). The location of the erosional edge of these units is uncertain, but it probably underlies the Charleston and Absaroka thrust faults south and north of the Uinta Mountains.

ORDOVICIAN STRATIGRAPHY

Ordovician rocks are missing in most of the stratigraphic cross section. According to Hintze (1988), either they were never deposited or they were deposited and subsequently removed by widespread erosion in Early Devonian time. Ordovician rocks were penetrated by one well (data point 1) on the Absaroka thrust plate. Stratigraphic nomenclature applied to the Upper Ordovician strata (in the subsurface and in outcrop) in this part of Utah is inconsistent and confusing. Typically, the Upper Ordovician rocks in Wyoming are assigned to the Bighorn Dolomite, whereas the time-equivalent rocks in north-central Utah are assigned to the Fish Haven Dolomite (Foster, 1972). The contact between the two units is located just east of the Idaho-Wyoming border (Armstrong and Oriel, 1965; Oriel and Platt, 1980). Similarly, Ott (1980) mapped Fish Haven Dolomite on the hanging wall of the Crawford thrust fault in the southern Crawford Mountains of Utah; the Bighorn Dolomite is the name used for similar rocks penetrated by wells to the east in Wyoming. However, the Bighorn Dolomite has been used to designate the Upper Ordovician strata penetrated by wells located on the hanging wall of the Absaroka thrust fault within the Utah part of the Sevier orogenic belt (Lamerson, 1982; West and Lewis, 1982). Although the term Fish Haven Dolomite is generally used to designate the Upper Ordovician rocks in northern Utah, the term Bighorn Dolomite is used in this study to designate the Upper Ordovician strata preserved on the hanging wall of the Absaroka thrust fault.

DEVONIAN STRATIGRAPHY

The oldest Devonian rocks found along the section line are Late Devonian age and follow the regional paleogeographic patterns of Rigby and Clark (1962), Baars (1972), Sandberg and others (1982), and Hintze (1988). On the western margin of the San Rafael Swell and Wasatch Plateau (data points 12, 26–31), the Upper Devonian is represented by the Elbert Formation and Ouray Limestone. The Pinyon Peak Limestone and Upper Devonian and Lower Mississippian Fitchville Formation are found west and north of the Wasatch Plateau along the section line (data points 7–11, 13–25). Even though the Upper Devonian formations were probably deposited under similar shallow-water conditions (Sandberg and others, 1982), the lateral continuity of these formations and the nature and location of the contact between these formations can not be conclusively demonstrated along the section line because of the lack of detailed subsurface control. For this study, the contact between the rocks of the San Rafael Swell and Wasatch Plateau (Elbert Formation and Ouray Limestone), and the rocks of similar age west of the Wasatch Plateau (Pinyon Peak Limestone and Fitchville Formation) was tentatively placed between the Hansen Oil Moroni 1AX and Phillips USA–E 1 wells (data points 25 and 26).

The age of the rocks of the Fitchville Formation is Late Devonian to Early Mississippian (Gutschick and others, 1980; Sandberg and Gutschick, 1979; Sandberg and others, 1982). The Devonian-Mississippian boundary within the Fitchville Formation is unconformable (Greenhalgh, 1980; Sandberg and others, 1982), but the unconformity is not shown on these cross sections.

MISSISSIPPIAN STRATIGRAPHY

Mississippian rocks within the Utah part of the Absaroka plate (data points 1–6) were assigned to the Lodgepole Limestone and Brazer Dolomite by Sandberg and others (1982) and Hintze (1988). Geophysical logs from the Amoco Island Ranching D–1 well (data point 1) indicate that the same interval of Mississippian rocks is found in the well and can be separated into a lower limestone and an upper dolomite. This subdivision is consistent with that of surface exposures of Lodgepole Limestone and Brazer Dolomite in the nearby Crawford Mountains (Sando and others, 1959; Sando and Dutro, 1960; Ott, 1980). Mississippian rocks that crop out near the western projection of the Uinta Mountains were assigned to the Fitchville Formation, Gardison Limestone, Deseret Limestone, and the Brazer Dolomite by Gutschick and others (1980).

Except for the Manning Canyon Shale (Poole and Sandberg, 1977), the top of the Mississippian section is unconformable with overlying strata along the section line. In central Utah (data points 13–25), the unconformity generally has been eroded down to the Deseret Limestone; the overlying Humbug Formation is locally preserved.

PENNSYLVANIAN STRATIGRAPHY

The section line generally crosses the stable shelf (the area east of the hingeline) that was present during Pennsylvanian time (Welsh and Bissell, 1979). However, thicker basinal depositional facies of the Oquirrh Formation (Bissell, 1962) are exposed in the hanging wall of the Charleston-Nebo thrust plate (data points 8–11) where they have been displaced eastward over the thinner shelf depositional facies (Baker, 1976). This relationship is visible in the Placid Oil Company well, Daniels Land #1 (data point 8), which penetrated the Oquirrh Formation. In this well, the Charleston thrust fault placed the Upper Mississippian to Lower Pennsylvanian Manning Canyon Shale over Jurassic rocks at 10,920 ft (3,328 m)(appendix). Below the thrust, the well penetrated an uninterrupted stratigraphic sequence and reached the Middle Pennsylvanian to Lower Permian Weber Sandstone at the bottom of the well. This relationship implies that the thinner shelf depositional facies (including the Round Valley Limestone and Weber Sandstone) underlie most of the Charleston-Nebo thrust plate, and that the boundary between the shelf depositional facies and the thicker basinal rocks lies to the west. South of the Charleston-Nebo thrust plate (data points 12–31), there are no Pennsylvanian rocks because of pre-Wolfcampian erosion of the Emery paleotopographic high in central Utah (Welsh and Bissell, 1979).

PERMIAN STRATIGRAPHY

The Emery paleotopographic high dominated depositional patterns in central Utah during most of the Permian Period. Much of the Permian section is missing on the western margin of the San Rafael Swell. The wells that penetrated rocks below the Permian section on the western margin of the San Rafael Swell (data points 29, 30) revealed that the White Rim Sandstone rests on the Mississippian Redwall Limestone. However, immediately westward under the Wasatch Plateau, rocks older than the White Rim Sandstone may be present in the subsurface (Hintze, 1988). According to an interpretation of the Phillips USA–E 1 well (data point 26) in Hintze (1988, chart 63, p. 169), the Elephant Canyon Formation consists of a sequence of dolomite, sandstone, and evaporite beds underlying the Toroweap Formation. However, there is little subsurface control and no paleontologic data to conclusively assign the beds that lie between the Toroweap Formation and the Redwall Limestone to the Elephant Canyon Formation. The use of the term Elephant Canyon Formation is under debate (Loope and others, 1990; Sanderson and Verville, 1990; Baars, 1991). The rocks identified as the Elephant Canyon Formation in the Phillips well do compare reasonably well with part of the lithologic sequence of the Toroweap Formation described by Rawson and Turner-Peterson (1979) in northern Arizona. Thus, the Permian sequence that underlies the Wasatch Plateau and surrounding area to the west is herein assigned to the Toroweap Formation.

The Black Box Dolomite (formerly Kaibab Limestone of Gilluly and Reeside, 1928) was named by Welsh and others (1979) for the Permian carbonate rocks deposited on the Emery paleotopographic high. The northern extent of Black Box Dolomite deposition is uncertain, but it probably intertongues with the Park City Formation under the Charleston-Nebo thrust plate.

Along the section line, the rocks of Permian age on the hanging wall of the Absaroka thrust fault consist of the Park City and Phosphoria Formations. The Park City and Phosphoria Formations represent a sequence of rocks that records the intertonguing relationship between shallow-water marine sedimentation and upwelling deeper-water marine sedimentation along a carbonate shelf (Peterson, 1980; Hintze, 1993). For this study, the Park City and Phosphoria Formations are graphically represented as one unit.

TRIASSIC STRATIGRAPHY

Rocks of the Triassic System found along the section line generally consist of Lower and Upper Triassic marine and nonmarine deposits separated by the Tr–3 unconformity (Pipiringos and O'Sullivan, 1978; Hintze, 1993). Most of the Middle Triassic rocks are missing. However, the lowermost beds of the Ankareh Formation and the uppermost beds of the Moenkopi Formation may be remnants of lower Middle Triassic rocks (Hintze, 1988).

The Lower and Middle(?) Triassic Moenkopi Formation of central Utah (data points 12–31) can be divided into several members (Irwin, 1971; Blakey, 1974; Hintze, 1988) and laterally grades northward into the Woodside Shale, Thaynes Formation, and possibly the lower part of the Ankareh Formation (data points 1–11). The individual members of the Moenkopi Formation were identified on geophysical logs and included on the stratigraphic cross section, but space constraints prohibited drawing the time lines on the time-stratigraphic cross section. Upper Triassic rocks found along the section line in central Utah (data points 12–31) include beds of the Chinle Formation. Similar to the underlying beds of the Moenkopi Formation, the Chinle Formation grades laterally northward into the Ankareh Formation.

According to Pipiringos and O'Sullivan (1978), the Tr–3 unconformity is an easily recognized regional surface in the Triassic. The unconformable surface separates the basal Upper Triassic Moss Back Member of the Chinle Formation from the underlying Lower Triassic Moenkopi Formation in central Utah, and the basal Upper Triassic Gartra Member of the Chinle Formation from the underlying Lower Triassic Moenkopi Formation in northeastern Utah (Poole and Stewart, 1964; Pipiringos and O'Sullivan, 1978). In northern Utah, the Tr–3 unconformity separates the basal Upper Triassic Gartra(?) Member of the Ankareh Formation from the underlying Lower Triassic Mahogany Member of the Ankareh Formation as mapped by Crittenden and others (1966) and Bromfield and Crittenden (1971). The stratigraphic relationship between the Moss Back and Gartra Members of the Chinle Formation in central and northeastern Utah is fairly well understood (Poole and Stewart, 1964). However, the stratigraphic relationship between the Gartra Member of the Chinle Formation of Poole and Stewart (1964) and the Gartra(?) Member of the Ankareh Formation as mapped by Crittenden and others (1966) and Bromfield and Crittenden (1971) is less well understood, and no definitive work has been published to clarify it. Thus, the Gartra(?) Member of the Ankareh Formation may not be a time-correlative unit to the Moss Back or Gartra Members of the Chinle Formation as shown on the time-stratigraphic cross section.

JURASSIC STRATIGRAPHY

The Middle Jurassic Arapien Shale (following the nomenclature of Witkind and Hardy, 1983), which consists of mudstone, limestone, and evaporite beds, was thought to overlie the Navajo Sandstone (Spieker, 1946; Hardy, 1952;

Imlay, 1967, 1980). Hardy (1952) conducted a detailed stratigraphic study of the Arapien Shale and noted that the predominately mudstone and evaporite section was underlain by a thick sequence of carbonate rocks. Hardy (1952) assigned these carbonate rocks to the lower part of the Arapien Shale, designating them as Unit A. Imlay (1967) suggested that the lower carbonate section of the Arapien Shale was probably correlative with beds of the lower part of the Twin Creek Limestone, and that the overlying mudstone and evaporite section of the Arapien Shale was correlative with the upper part of the Twin Creek Limestone. Sprinkel (1982) and Sprinkel and Waanders (1984), using palynologic and other subsurface data, correlated this sequence of lower carbonate rocks (which persistently separate the Navajo Sandstone from the predominately mudstone and evaporite section of the Arapien Shale) with Imlay's (1967, 1980) lower five members (Gypsum Spring, Sliderock, Rich, Boundary Ridge, and Watton Canyon Members) of the Twin Creek Limestone of northern Utah. Only the upper two members (Leeds Creek and Giraffe Creek Members) of the Twin Creek Limestone were correlative with the Arapien Shale (Sprinkel and Waanders, 1984), as shown between data points 7 and 8.

The areal extent of the Arapien Shale was formerly regarded as limited to eastern Juab, Sanpete, and western Sevier Counties (Spieker, 1946; Hardy, 1952). However, Sprinkel and Waanders (1984) suggested that the Arapien Shale may extend as far north as the southern flank of the Uinta Mountains, and that the lithofacies boundary between the Arapien Shale and the upper two members of the Twin Creek Limestone must be located near the western projection of the Uinta Mountains. The location of this hypothesized stratigraphic relationship is based on my interpretation of the Arapien Shale and Twin Creek Limestone lithofacies along and near the section line. Rocks of the Arapien Shale are believed to overlie the Twin Creek Limestone in both the hanging wall and footwall of the Charleston-Nebo thrust plate. The Arapien Shale in the hanging wall was penetrated in two wells located near Indianola (data points 13 and 14) and crops out at Red Canyon (Biek, 1991) and Thistle (Witkind and Page, 1983). The Leeds Creek Member of the Twin Creek Limestone was identified at Monks Hollow by Imlay (1967); he described it as being similar to the upper shaley part of the Arapien Shale. Similarly, Baker (1976) mapped the only complete section of Twin Creek Limestone in the area surrounding Monks Hollow. Although he did not map its individual members, Baker (1976) described the Twin Creek Limestone as having an upper shaley part and a lower limey part. I believe that the beds formerly identified as the Leeds Creek Member at Monks Hollow are beds of the Arapien Shale, based on their distinctively drab appearance (characteristic of the Arapien Shale), their high percentage of mudstone, and the presence of gypsum. The northernmost occurrence of Arapien Shale in the cross section is thought to be located on the footwall of the Charleston-Nebo thrust plate in the Placid Oil Company Daniels Land #1 well (data point 8). In this well, 473 ft (144 m)(appendix) of dark-gray mudstone, limestone, and anhydrite beds assigned to the Arapien Shale are structurally overlain by the Charleston thrust fault and rest on beds identified as the Watton Canyon Member of the Twin Creek Limestone.

There is a great deal of variation of bed thickness in the Jurassic Arapien Shale. In central Utah (data points 12–26), it ranges from about 1,000 ft (305 m) thick under the Wasatch Plateau to about 11,000 ft (3,353 m) thick near the axis of the Sanpete-Sevier Valley anticline (Gilliland, 1963). Along the section line, the thickness of the Arapien Shale averages 3,500 ft (1,067 m). I believe the maximum depositional thickness of the Arapien Shale is only about 2,000 to 3,000 ft (610 to 914 m) and is less than that suggested by Standlee (1982). In making his thickness estimates, Standlee (1982) included the Twin Creek Limestone with the Arapien Shale, in contrast to Sprinkel (1982). Standlee (1982) also used two wells, the Dixel Gunnison State #1 (data point 21) and the Chevron Chriss Canyon Unit #1 (NE¼NW¼ sec. 33, T. 16 S., R. 1 E., Sanpete County) to estimate depositional thickness. Both of these wells are in the zone of imbricate thrusting and post-thrusting diapirism where it is difficult to rule out structural thickening of the Arapien Shale because of compressional folding, imbricate thrust splays, and diapirism. Lawton (1985) estimated that the thickness of the Middle Jurassic section in central Utah may have been doubled by thrusting. However, it is difficult to rule out concurrent diapiric movement of the Arapien Shale during thrusting events. The thicker sections of Arapien Shale are, therefore, attributed to tectonic thickening by thrusting and folding during the Sevier orogeny and post-thrusting mobilization of Arapien strata by diapirism (Standlee, 1982; Witkind, 1982; Lawton, 1985; Villien and Kligfield, 1986; Willis, 1986, 1988).

The age of the Twist Gulch Formation, which overlies the Arapien Shale (data points 12, 18–26), is uncertain. Imlay (1980) considered it to be lower to middle Callovian, based on its stratigraphic position and its similarity to the Preuss Sandstone. In addition, beds exposed in the upper 177 ft of the Twist Gulch Formation near Salina Canyon (Willis, 1986) are similar to beds of the Curtis Formation exposed on the San Rafael Swell, which Imlay (1980) considered to be upper middle Callovian. However, Villien and Kligfield (1986) found Early Cretaceous palynomorphs in rocks mapped as Twist Gulch Formation by Hunt (1950) and Hardy and Zeller (1953) along Chicken Creek in the Gunnison Plateau. Auby (1991) assigned rocks that were previously included in the upper part of the Twist Gulch Formation by Hunt (1950) and Hardy and Zeller (1953) to the Lower Cretaceous Cedar Mountain Formation. The rocks described by Villien and Kligfield (1986) probably belong to the Cedar Mountain Formation, not the Twist Gulch Formation. Thus, the Twist Gulch Formation shown on the cross section is similar to the work of Imlay (1980).

The age of the Morrison Formation is considered to be Late Jurassic by Imlay (1980). Laser fusion argon-argon dating of rock samples collected in the Morrison Formation also indicates that the Morrison Formation is Late Jurassic age (Kowallis and Christensen, 1991; Kowallis and others, 1992). The Late Jurassic age of the Morrison Formation revises an earlier report by Kowallis and Heaton (1987), which suggested that the Morrison Formation (Brushy Basin Member) may be Early Cretaceous age.

CRETACEOUS STRATIGRAPHY

Lower and Upper Cretaceous rocks along the section line generally parallel the migrating shorelines of the Western Interior, as shown in regional paleogeographic reconstructions (McGookey and others, 1972; Ryer and McPhillips, 1983; Franczyk and others, 1992). However, much of the present-day distribution of Cretaceous rocks along the section line is the result of the tectonic influence of the Sevier orogenic belt. In the northern part of the cross section (data points 1–7), the Lower Cretaceous is represented by the Kelvin Formation and the lower part of the Aspen Shale; the Upper Cretaceous is represented by the upper part of the Aspen Shale, Frontier Formation, and lower part of the Evanston Formation (Hale, 1960a, 1960b; Crittenden, 1963; Ryer, 1977; Jacobson and Nichols, 1982; Nichols and Jacobson, 1982a, 1982b; Nichols and others, 1982; Bryant and Nichols, 1988; Bryant, 1990; Franczyk and others, 1992). Along the section line, both Lower and Upper Cretaceous rocks are present on the hanging wall of the Absaroka thrust plate, whereas only Lower Cretaceous rocks are present on the footwall.

All of the Lower Cretaceous rocks and most of the Upper Cretaceous rocks are missing on the hanging wall of the Charleston-Nebo thrust plate (data points 8–11). However, Lower and Upper Cretaceous rocks are believed to underlie the leading edge of the Charleston-Nebo thrust plate (W.A. Yonkee, oral commun., 1990). Although well data has not confirmed that Cretaceous units underlie the leading edge of the Charleston-Nebo thrust fault, the stratigraphic section (if preserved intact) is probably represented by rocks of the Dakota Sandstone, Mancos Shale, and Mesaverde Group (Franczyk and others, 1992). Until well data becomes available, the detailed stratigraphic relationships among the Cretaceous units on the footwall of the Charleston-Nebo thrust fault and the time-stratigraphic equivalent beds of the Absaroka thrust plate remain uncertain.

Lower Cretaceous stratigraphy in central Utah (data points 12–26) has been entangled in problems of nomenclature. Speiker (1946) originally assigned outcrops of variegated beds that rest on the Middle Jurassic Twist Gulch Formation and underlie the Upper Cretaceous Sanpete Formation to the Morrison(?) Formation. Spieker's (1946) Morrison(?) Formation consists of two distinctive and easily recognizable lithostratigraphic units: a lower variegated mudstone unit and an upper conglomerate unit (Witkind and others, 1986). The lower variegated mudstone unit also includes beds of siltstone, pebbly sandstone, some limestone, and distinctive limestone nodules. The upper conglomerate unit is interbedded with sandstone and mudstone, and contains distinctive green quartzite clasts (Sprinkel and others, 1992). Formal abandonment of the Morrison(?) Formation was first recommended by Witkind and others (1986). They reassigned beds of the lower variegated mudstone unit to the Cedar Mountain Formation based on lithologic similarity (particularly the distinctive limestone nodules) to the Cedar Mountain Formation exposed in the San Rafael Swell (Stokes, 1944, 1952); however, the authors disagreed on the reassignment of the upper conglomerate unit. Co-author L.E. Standlee believed that the upper conglomerate unit was an unrecognized lithofacies of the Cedar Mountain Formation, whereas co-authors I.J. Witkind and K.F. Maley believed that it should be reassigned to the overlying Indianola Group (Witkind and others, 1986). Similarly, Weiss and Roche (1988) assigned the lower variegated mudstone unit to the Cedar Mountain Formation and proposed that the upper conglomerate unit be a new unnamed basal unit of the Indianola Group. In addition, Weiss (1990) recently mapped the variegated mudstone beds as part of the Cedar Mountain Formation and the overlying conglomerate unit as the basal conglomerate of the Indianola Group. Weiss (1990) did not formally propose a name for the upper conglomerate unit because he believed additional work was needed to determine its regional extent. In the same publication that the Weiss and Roche (1988) paper appeared, Schwans (1988) defined a new formation, the Pigeon Creek Formation, for the lower variegated mudstone unit and the upper conglomerate unit of Spieker's (1946) Morrison(?) Formation. Schwans (1988) believed that these rocks were restricted to central Utah and represented a significant unconformity-bounded sequence of the early Cordilleran foreland basin. Schwans (1988) also recognized the distinctive lithologic boundary between the lower variegated mudstone unit (lower Pigeon Creek member) and the upper conglomerate unit (upper Pigeon Creek member). Recent work in the extreme southeastern part of the Gunnison Plateau by Sprinkel and others (1992) corroborated the work of Witkind and others (1986), Weiss and Roche (1988), and Weiss (1990) by assigning the lower variegated mudstone unit to the Cedar Mountain Formation and designating the upper conglomerate unit as an unnamed (synorogenic clastic unit) conglomerate. For this report, I correlated the Cedar Mountain Formation of the San Rafael Swell region (data points 29–31) into central Utah (data points 12, 19–26) using geophysical and mud logs; however, the overlying unnamed conglomerate unit does not extend eastward beyond the central part of the Wasatch Plateau (data point 26). Thus, in this report, the name Cedar Mountain Formation is assigned in the restricted sense (Witkind and others, 1986; Weiss and Roche, 1988) and as mapped by Weiss (1990) and Auby

(1991). Also in this report, the overlying unnamed conglomerate is considered to be a discrete mappable unit and is not assigned to either the underlying Cedar Mountain Formation or the overlying Indianola Group (Sprinkel and others, 1992). The Cedar Mountain Formation is considered to be Aptian-Albian in age (Tschudy and others, 1984; Witkind and others, 1986) and the unnamed conglomerate is Aptian to middle Albian in age (Witkind and others, 1986; Sprinkel and others, 1992).

During the Late Cretaceous period in central Utah (data points 12–31), clastic marine and nonmarine rocks were deposited within a foreland basin (Lawton, 1982; Franczyk and others, 1992). The pattern of sedimentation within the basin generally was controlled by its proximity to the emerging Sevier orogenic belt and eustatic changes of sea level (Lawton, 1982; Franczyk and others, 1992). The stratigraphic section is dominated by a marine depositional facies in the lower part that grades upward into (and interfingers with) nonmarine depositional facies in the upper part (Lawton, 1982, 1983, 1985, 1986; Fouch and others, 1982, 1983; Franczyk and others, 1992). The vertical succession from marine to nonmarine depositional facies is also duplicated laterally as the Cretaceous seas transgressed westward and then retreated in response to the eastward-advancing thrust belt and associated fluvial sedimentation (Franczyk and others, 1992).

Upper Cretaceous rocks along the eastern part of the cross section in central Utah (data points 12, 26–31) are the Dakota Sandstone, Mancos Shale, and Mesaverde Group (Franczyk and others, 1992). These formations are exposed on the east side of the Wasatch Plateau (Witkind and others, 1987; Witkind, 1988) and are informally referred to in this report as the eastern depositional facies. To the west (data points 13–25), Upper Cretaceous rocks include the Sanpete Formation, Allen Valley Shale, Funk Valley Formation, and Sixmile Canyon Formation of the Indianola Group (Spieker, 1949; Weiss, 1990; Franczyk and others, 1992). Rocks of the Indianola Group are coarser grained than the time-equivalent rocks (Dakota Sandstone, Mancos Shale, and Mesaverde Group) exposed to the east and the group is informally referred to in this report as the western depositional facies. Correlation of the eastern and western depositional facies is similar to the work of Lawton (1982, 1983, 1985, 1986), Fouch and others (1982, 1983), and Franczyk and others (1992).

The lithologic changes between the eastern and western depositional facies underlies the west-central part of the Wasatch Plateau. Near the center of the Wasatch Plateau, the Phillips USA–E 1 well (data point 26) penetrated Upper Cretaceous rocks that, from geophysical logs and mudlogs, appear to be similar to rocks of both the eastern and western depositional facies. The strata assigned to the Dakota Sandstone and Emery Sandstone Member of the Mancos Shale that were found in the Phillips USA–E 1 well are similar to that of the western depositional facies. The Dakota Sandstone is typically 50 to 150 ft (15 to 46 m) thick and contains carbonaceous material. Strata of the Dakota Sandstone found in the above-mentioned well is much thicker and coarser. Similarly, the strata assigned to the Emery Sandstone Member of the Mancos Shale found in the Phillips USA–E 1 well are much thicker and coarser, and contain more thin coal beds than do Emery strata exposed to the east. However, the Tununk and Blue Gate Members of the Mancos Shale found in the well contain thick beds of marine shale typical of the Upper Cretaceous rocks exposed on the east side of the Wasatch Plateau. Although the Upper Cretaceous rocks found in the Phillips USA–E 1 well are a thicker and coarser sequence of rocks (characteristics of the western depositional facies), nomenclature typical of rocks exposed on the east side of the Wasatch Plateau is recommended for this part of the Wasatch Plateau (Lawton, oral commun., 1990).

TERTIARY STRATIGRAPHY

This part of the report focuses on the Tertiary rocks located along the section line south of the Uinta Mountains (data points 9–25). The North Horn Formation is discussed in the Tertiary section of this report even though the lower part of the North Horn Formation can be as old as Late Cretaceous (Maastrichtian) in the Wasatch Plateau area (data points 12, 26) (Fouch, 1983, fig. 2; Franczyk and others, 1992). However, the lower part of the North Horn Formation in the San Pitch Mountains and the surrounding area (data points 13–25), and in the western Uinta basin area (data points 9-11) may be considerably younger (late Paleocene) (Fouch, 1983, fig. 2; Bryant and others, 1989a; Franczyk and others, 1992).

Along the part of the section line that is within the western Uinta basin, the Tertiary rocks belong to the North Horn Formation, the Flagstaff Member of the Green River Formation, the Colton Formation, the Green River Formation, and the Duchesne River Formation (Fouch, 1976; Bryant and others, 1989; Franczyk and others, 1992). This stratigraphic sequence rests unconformably on part of the allochthonous upper Paleozoic strata of the Charleston-Nebo thrust plate (Baker, 1976). Three wells in the western Uinta basin (data points 9–11) penetrated a thick section of predominately fluvial and lacustrine strata, which also unconformably overlies allochthonous Paleozoic strata. Although the stratigraphic section probably includes beds of the Flagstaff Member of the Green River Formation and the Colton Formation, a detailed correlation chart that included the nearby exposures mapped by Bryant and others (1989) was not attempted because mud logs were unavailable and not all of the geophysical logs were run over the entire stratigraphic sequence in the wells located along the section line. Future work using well cuttings or mud logs from these wells (data points 9–11) will probably reveal the carbonate beds that are characteristic of the Flagstaff Member of the Green River

Formation and that separate the red clastic beds of the overlying Colton Formation and underlying North Horn Formation. For this report, I tentatively separated a lower sandier lithofacies from an upper muddier lithofacies using the available geophysical logs. The North Horn Formation represents the sandier lithofacies and the Green River Formation represents the muddier lithofacies.

The revised nomenclature of the lower part of the Tertiary System proposed by Fouch (1976) applies only to the central and western Uinta Basin. Paleocene and Eocene rocks in central Utah (data points 12–26) include part of the North Horn Formation and the Flagstaff Limestone (locally the Flagstaff Formation); Eocene rocks in this area include the Colton Formation, the Green River Formation, and the Crazy Hollow Formation (Spieker, 1946, 1949; Fouch and others, 1982, 1983; Weiss, 1982; Lawton, 1985; Willis, 1986, 1988; Marcantel and Weiss, 1968; Franczyk and others, 1992). Depositional environments and intertonguing relationships of these units are similar to those rocks in the western Uinta Basin (Franczyk and others, 1992).

The Flagstaff Limestone exposed on the Wasatch Plateau is mostly limestone (as the name implies) and is separated into three members (Stanley and Collinson, 1979). South and west of the Wasatch Plateau, the Flagstaff Limestone loses its predominantly limestone lithology and laterally grades to sandstone, conglomerate, and mudstone with some interbedded limestone. In the areas south and west of the plateau, the name Flagstaff Formation is used to show that this unit is a mixture of lithologies (Willis, 1986, 1988, 1991). The age of the Flagstaff Limestone is Paleocene to early Eocene (LaRocque, 1960).

An unconformity marks the base of the North Horn Formation, but the contacts between the North Horn Formation, Flagstaff Limestone, Colton Formation, and Green River Formation are conformable (Fouch and others, 1983). However, locally each of these units may unconformably rest on Cretaceous or older strata. Local paleohighs or islands in central Utah were created by thrusting (Standlee, 1982), diapirism within the Arapien Shale (Witkind, 1982), or both (Lawton, 1985; Villien and Kligfield, 1986; Willis, 1986, 1988; Mattox, 1992; Weiss, 1990). These paleohighs probably controlled deposition of the North Horn Formation and possibly the Flagstaff Limestone (Witkind, 1982; Lawton, 1985; Mattox, 1992; Weiss, 1990). Sporadic episodes of diapiric movement in the Arapien Shale locally controlled the deposition of the post-Flagstaff strata (Witkind, 1982; Witkind and Page, 1984; Lawton, 1985; Willis, 1986, 1988; Mattox, 1992; Weiss, 1990).

The predominant late Eocene and Oligocene rocks in the cross section are pyroclastic and volcaniclastic rocks, although sedimentary rocks of the Duchesne River Formation are also present (Bryant and others, 1989a). The Keetley Volcanics are exposed near the west end of the Uinta Mountains (data point 7); the Goldens Ranch and Moroni Formations crop out to the south in central Utah (data 15–20) (Bryant and others, 1989a). Witkind and Marvin (1989) described the evolution of nomenclature for the Goldens Ranch and Moroni Formations, and discussed the radiometric age and lithologic similarities of the two units. They concluded that the two units are identical lithologically, but they recommended that both formation names be retained because they were unable to confirm physical continuity between the two units and both names were well established in the literature. They recommended that the use of the term Goldens Ranch Formation be restricted to areas surrounding Juab Valley (eastern Juab County) and that use of the term Moroni Formation be restricted to areas surrounding Sanpete Valley (western Sanpete County).

QUATERNARY STRATIGRAPHY

The section line crosses a variety of Quaternary deposits that are not represented on the cross section because these deposits are generally thin, localized, and were not mapped in sufficient detail. They include alluvial, colluvial, eolian, and mass-wasting deposits. However, in a few areas along the section line (data points 18–20, 22–24) where the Quaternary units were mapped in detail, units of the Lake Bonneville Group, the alluvium in southern Juab Valley (Oviatt, 1992), and the alluvium in Sanpete Valley (Weiss, 1990) are shown on the cross section.

ACKNOWLEDGMENTS

I wish to thank the geologists who generously took time to share their knowledge of regional stratigraphic and structural relationships, which helped solve many of the problems encountered during the construction of these cross sections. Discussions with Utah Geological Survey geologists Hellmut Doelling, Lehi Hintze, Alec Keith, Michael Ross, Grant Willis, and Adolf Yonkee of Weber State University, and Tim Lawton of New Mexico State University made this project an exhilarating exercise. I also thank Floyd Moulton and Frank P. Turner who provided mudlogs and other well information for several wells used in the cross section. I am deeply indebted to the reviewers, Sam Johnson and Tom Fouch (U.S. Geological Survey), Hellmut Doelling, and Lehi Hintze. Their comments greatly improved the quality of the cross sections and manuscript. Finally, I wish to thank Sam Johnson for all of his help and advice, and M. Lee Allison (Utah Geological Survey) for allowing me to shed the surly bonds of "administrivia" to undertake and complete this project.

REFERENCES CITED

Armstrong, F.C., and Oriel, S.S., 1965, Tectonic development of Idaho-Wyoming thrust belt: American Association of Petroleum Geologists Bulletin, v. 49, no. 11, p. 1847–1866.

Armstrong, R.L., 1968, Sevier orogenic belt in Nevada and Utah: Geological Society of America Bulletin, v. 79, no. 4, p. 429–458.

Auby, W.L., 1991, Provisional geologic map of the Levan quadrangle, Juab County, Utah: Utah Geological Survey Map 135, 13 p., scale 1:24,000.

Baars, D.L., 1972, Devonian System, *in* Mallory, W.M., ed., Geologic atlas of the Rocky Mountain region: Rocky Mountain Association of Geologists, p. 90–99.

Baars, D.L., 1991, The Elephant Canyon Formation—for the last time: The Mountain Geologist, v. 28, no. 1, p. 1–2.

Baker, A.A., 1976, Geologic map of the west half of the Strawberry Valley quadrangle, Utah: U.S. Geological Survey Miscellaneous Investigations Map I–931, scale 1:63,360.

Banks, R.L., 1991, Provisional geologic map of Fountain Green North quadrangle, Sanpete and Juab counties, Utah: Utah Geological Survey Map 134, 21 p., scale 1:24,000.

Biek, R.F., 1991, Provisional geologic map of the Nephi quadrangle, Juab County, Utah: Utah Geological Survey Map 137, 21 p., scale 1:24,000.

Bissell, H.J., 1962, Pennsylvanian-Permian Oquirrh Basin of Utah: Brigham Young University Geology Studies, v. 9, part 1, p. 26–49.

Blakey, R.C., 1974, Stratigraphic and depositional analysis of the Moenkopi Formation, southeastern Utah: Utah Geological and Mineral Survey Bulletin 104, 81 p.

Bryant, Bruce, 1991, Geologic map of the Salt Lake City 30′×60′ quadrangle, north-central Utah, and Uinta County, Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I–1944, scale 1:100,000.

Bryant, Bruce, Naesser, C.W., Marvin, R.F., and Mehnert, H.H, 1989a, Upper Cretaceous and Paleogene sedimentary rocks and isotopic ages of Paleogene tuffs, Uinta basin, Utah: U.S. Geological Survey Bulletin 1787–J, 22 p.

———1989b, Ages of late Paleogene and Neogene tuffs and the beginning of rapid regional extension, eastern boundary of the Basin and Range province near Salt Lake City, Utah: U.S. Geological Survey Bulletin 1787–K, 12 p.

Bryant, Bruce, and Nichols, D.J., 1988, Late Mesozoic and early Tertiary reactivation of an ancient crustal boundary along the Uinta trend and its interaction with the Sevier orogenic belt *in* Schmidt, C.J., and Perry, W.J., Jr., eds., Interaction of the Rocky Mountain foreland and the Cordilleran thrust belt: Geological Society of America Memoir 171, p. 411–430.

Bromfield, C.S., Baker, A.A., and Crittenden, M.D., Jr., 1970, Geologic map of the Heber quadrangle, Wasatch and Summit counties, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ–864, scale 1:24,000.

Bromfield, C.S., and Crittenden, M.D., Jr., 1971, Geologic map of the Park City East quadrangle, Summit and Wasatch counties, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ–852, scale 1:24,000.

Crittenden, M.D., Jr., 1963, Emendation of the Kelvin Formation and Morrison(?) Formation near Salt Lake City, Utah: U.S. Geological Survey Professional Paper 475–B, p. B95–B98.

———1974, Regional extent and age of thrusts near Rockport Reservoir and relation to possible exploration targets in northern Utah: American Association of Petroleum Geologists Bulletin, v. 58, no. 12, p. 2428–2435.

Crittenden, M.D., Jr., Calkins, F.C., and Sharp, B.J., 1966, Geologic map of the Park City West quadrangle, Utah: U.S. Geological Survey Geologic Quadrangle Map GQ–535, scale 1:24,000.

Foster, N.H., 1972, Ordovician System, *in* Mallory, W.M., ed., Geologic atlas of the Rocky Mountain region: Rocky Mountain Association of Geologists, p. 76–85.

Fouch, T.D., 1976, Revisions of the lower part of the Tertiary System in the central and western Uinta basin, Utah: U.S. Geological Survey Bulletin 1405–C, 7 p.

Fouch, T.D., Lawton, T.F., Nichols, D.J., Cashion, W.B., and Cobban, W.A., 1982, Chart showing preliminary correlation of major Albian to middle Eocene rock units from the Sanpete Valley in central Utah to the Book Cliffs in eastern Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 267–272.

———1983, Patterns and timing of synorogenic sedimentation in Upper Cretaceous rocks of central and northeast Utah, *in* Reynolds, M.W., and Dolly, E.D., eds., Mesozoic Paleogeography of west-central United States, Society of Economic Paleontologists and Mineralogists: Rocky Mountain Paleogeography Symposium 2, p. 305–336.

Franczyk, K.J., 1991, Stratigraphic and time-stratigraphic cross sections of Phanerozoic rocks along line C–C′, Uinta and Piceance basin area, southern Uinta Mountains to northern Henry Mountains, Utah: U.S. Geological Survey Miscellaneous Investigations Map I–2184–C.

Franczyk, K.J., Fouch, T.D., Johnson, R.C., Molenaar, C.M., and Cobban, W.A., 1992, Cretaceous and Tertiary paleogeographic reconstructions for the Uinta-Piceance basin study area, Colorado and Utah: U.S. Geological Survey Bulletin 1787–Q, 37 p.

Gilliland, W.N., 1963, Sanpete-Sevier Valley anticline of central Utah: Geological society of America Bulletin, v. 74, no. 2, p. 115–123.

Gilluly, J., 1929, Geology and oil and gas prospects of part of the San Rafael Swell, Utah: U.S. Geological Survey Bulletin 806–C, p. 69–130.

Gilluly, J., and Reeside, J.B., Jr., 1928, Sedimentary rocks of the San Rafael Swell and some adjacent areas in eastern Utah: U.S. Geological Survey Professional Paper 150, p. 61–110.

Greenhalgh, B.R., 1980, The Fitchville Formation: a study of biostratigraphy and depositional environments in west-central Utah County, Utah: Brigham Young University Geology Studies, v. 27, part 1, p. 9–29.

Gutschick, R.C., Sandberg, C.A., and Sando, W.J., 1980, Mississippian shelf margin and carbonate platform from Montana to Nevada, *in* Fouch, T.D., and Magathan, E.R., eds., Paleozoic paleogeography of the west-central United States: Society of Economic Paleontologists and Mineralogists, Rocky Mountain Section, Rocky Mountain Paleogeography Symposium 1, June 1980, Denver, CO, p. 111–128.

Hale, L.A., 1960a, Frontier Formation-Coalville, Utah and nearby areas of Wyoming and Colorado, *in* McGookey, D.P., and Miller, D.N., Jr., eds., Overthrust belt of southwestern Wyoming and adjacent areas: Wyoming Geological Association 15th Annual Field Conference Guidebook, p. 137–146.

———1960b, Annotations to accompany Cretaceous correlation chart, *in* McGookey, D.P., and Miller, D.N., Jr., eds., Overthrust Belt of southwestern Wyoming and adjacent Areas:

Wyoming Geological Association 15th Annual Field Conference Guidebook, p. 131–135.

Haq, B.U., and Van Eysinga, F.W.B., 1987, Geologic Time Table: Amsterdam, Elsevier Science Publishers B.V., 1 chart.

Hardy, C.T., 1952, Eastern Sevier Valley, Sevier and Sanpete counties, Utah: Utah Geological and Mineral Survey Bulletin 43, 98 p.

Hardy, C.T., and Zeller, H.D., 1953, Geology of the west-central part of the Gunnison Plateau, Utah: Geological Society of America Bulletin, v. 64, no. 11, p. 1261–1278.

Hintze, L.F., 1988, Geologic History of Utah: Brigham Young University Geology Studies Special Publication 7, 202 p. (Reprinted with minor revisions July, 1993).

Hunt, R.E., 1950, Geology of the northern part of the Gunnison Plateau: Columbus, Ohio State University, Ph.D. dissertation, 267 p.

Imlay, R.W., 1967, Twin Creek Limestone (Jurassic) in the western interior of the United States: U.S. Geological Survey Professional Paper 540, 105 p.

———1980, Jurassic paleobiogeography of the conterminous United States in its continental setting: U.S. Geological Survey Professional Paper 1062, 134 p.

Irwin, C.D., 1971, Stratigraphic analysis of upper Permian and lower Triassic strata in southern Utah: American Association of Petroleum Geologists Bulletin, v. 55, no. 11, p. 1976–2007.

Jacobson, S.R., and Nichols, D.J., 1982, Palynological dating of syntectonic units in the Utah/Wyoming thrust belt: The Evanston Formation, Echo Canyon Conglomerate, and Little Muddy Creek Conglomerate, *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 2, p. 735–750.

Jefferson, W.S., 1982, Structural and stratigraphic relations of Upper Cretaceous to lower Tertiary orogenic sediments of the Cedar Hills, Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 65–80.

Johnson, R.C., and Johnson, S.Y., 1991, Stratigraphic and time-stratigraphic cross sections of Phanerozoic rocks along line B–B′, Uinta and Piceance basin area, west-central Uinta basin, Utah, to eastern Piceance basin, Colorado: U.S. Geological Survey Miscellaneous Investigations Map I–2184–B.

Johnson, S.Y., and Johnson, R.C., 1991, Stratigraphic and time-stratigraphic cross sections of Phanerozoic rocks along line A–A′, Uinta and Piceance basins area–Eagle Basin, Colorado, to eastern Basin and Range, Utah: U.S. Geological Survey Miscellaneous Investigations Map I–2184–A.

Kowallis, B.J., and Christiansen, E.H., 1991, Correlation of altered volcanic ash in the Brushy Basin Member of the Morrison Formation, Colorado Plateau [abs.]: Geological Society of America Abstracts with Program, v. 23, no. 5, p. A295.

Kowallis, B.J., Christiansen, E.H., and Tingey, D.G., 1993, Volcanic ash layers in the Tidwell Member of the Upper Jurassic Morrison Formation: minimum age of the J–5 unconformity on the Colorado Plateau [abs.]: Geological Society of America Abstracts with Programs, v. 25, no. 6, p. A472–A473.

Kowallis, B.J., and Heaton, J.S., 1987, Fission-track dating of bentonites and bentonitic mudstones from the Morrison Formation in central Utah: Geology, v. 15, p. 1138–1142.

Lamerson, P.R., 1982, The Fossil Basin and its relationship to the Absaroka thrust system, Wyoming and Utah, *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 1, p. 279–340.

LaRocque, Aurele, 1960, Molluscan faunas of the Flagstaff formation of central Utah: Geological Society of America Memoir 78, 100 p.

Lawton, T.F., 1982, Lithofacies correlations within the Upper Cretaceous Indianola Group, central Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 199–213.

———1983, Late Cretaceous fluvial systems and the age of foreland uplifts in central Utah, *in* Lowell, J.D., ed., Rocky Mountain foreland basins and uplifts: Rocky Mountain Association of Geologists, p. 181–200.

———1985, Style and timing of frontal structures, Thrust Belt, central Utah: American Association of Petroleum Geologists Bulletin, v. 69, no. 7, p. 1145–1159.

———1986, Fluvial systems of Upper Cretaceous Mesaverde Group and Paleocene North Horn Formation, central Utaha record of transition from thin-skinned to thick-skinned eformation in the foreland region, *in* Peterson, J.A., ed., Paleotectonics and sedimentation in the Rocky Mountain region: American Association of Petroleum Geologists Memoir 41, p. 423–442.

Lochman-Balk, C., 1972, Cambrian System, *in* Mallory, W.M., ed., Geologic atlas of the Rocky Mountains region: Rocky Mountain Association of Petroleum Geologists, p. 60–75.

———1976, Cambrian Section of the central Wasatch Mountains, *in* Hill, J.G., ed., Symposium on Geology of the Cordilleran Hingeline, p. 103–108.

Loope, D.B., Sanderson, G.A., and Verville, G.J., 1990, Abandonment of the Name "Elephant Canyon Formation" in southeastern Utah: physical and temporal implications: The Mountain Geologist, v. 27, no. 4, p. 119–130.

Mattox, S.R., 1987, Provisional geologic map of the Hell's Kitchen Canyon SE quadrangle, Sanpete County, Utah: Utah Geological and Mineral Survey Map 98, 17 p., scale 1:24,000.

———1992, Provisional geologic map of the Gunnison quadrangle, Sanpete County, Utah: Utah Geological Survey Map 139, 11 p., scale 1:24,000.

Marcantel, E.L., and Weiss, M.P., 1968, Colton Formation (Eocene fluviatile) and associated lacustrine beds, Gunnison Plateau, central Utah: The Ohio Journal of Science, V. 68, p. 40–49.

Maughan, E.K., 1984, Geological setting and some geochemistry of petroleum source rocks in the Permian Phosphoria Formation, *in* Woodward, Jane, and others, eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Rocky Mountain Association of Geologists, p. 281–294.

McGookey, D.P., Haun, J.D., Hale, L.A., Goodell, H.G., McCubbin, D.G., Weimer, R.J., and Wulf, G.R., 1972, Cretaceous System, *in* Mallory, W.M., ed., Geologic atlas of the Rocky Mountain region: Rocky Mountain Association of Geologists, p. 190–228.

Mullens, T.E., 1971, Reconnaissance study of the Wasatch, Evanston, and Echo Canyon Formations in part of northern Utah: U.S. Geological Survey Bulletin 1311–D, 31 p.

Nichols, D.J., and Bryant, Bruce, 1986a, Palynology of the Current Creek and Mesaverde Formations in the Currant Creek–Duchesne River area, Duchesne and Wasatch counties, Utah: U.S. Geological Survey Open-File Report 86–160, 7 p.

———1986b, Palynologic data from Cretaceous and early Tertiary rocks in the Salt Lake 30′×60′ quadrangle: U.S. Geological Survey Open-File Report 86–116, 18 p.

Nichols, D.J., and Jacobson, S.R., 1982a, Cretaceous biostratigraphy in the Wyoming Thrust Belt: The Mountain Geologist, v. 19, no. 3, p. 73–78.

———1982b, Palynostratigraphic framework for the Cretaceous (Albian-Maestrichtian) of the Overthrust Belt of Utah and Wyoming: Palynology, v. 6, p. 119–147.

Nichols, D.J., Jacobson, S.R., and Tschudy, R.H., 1982, Cretaceous palynomorph biozones for the central and northern Rocky Mountain region of the United States, *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 2, p. 721–733.

Oriel, S.S., and Platt, L.B., 1980, Geologic Map of the Preston 1°×2° quadrangle, southeastern Idaho and western Wyoming: U.S. Geological Survey Miscellaneous Investigations Map I–1127, scale 1:250,000.

Ott, V.D., 1980, Geology of the Woodruff Narrows quadrangle, Utah-Wyoming: Brigham Young University Geology Studies, v. 27, part 2, p. 67–84.

Oviatt, C.G., 1992, Quaternary geology of the Scipio Valley area, Millard and Juab counties, Utah: Utah Geological Survey Special Studies 79, 16 p.

Peterson, J.A., 1980, Permian paleogeography and sedimentary provinces, west-central United States, *in* Fouch, T.D., and Magathan, E.R., eds., Paleozoic paleogeography of the west-central United States: Society of Economic Paleontologists and Mineralogists, Rocky Mountain Section, Rocky Mountain Paleogeography Symposium 1, June 1980, Denver, CO, p. 111–128.

Pipiringos, G.N., and Imlay, R.W., 1979, Lithology and subdivisions of the Jurassic Stump Formation in southeastern Idaho and adjoining areas: U.S. Geological Survey Professional Paper 1035–C, 25 p.

Pipiringos, G.N., and O'Sullivan, R.B., 1978, Principal unconformities in Triassic and Jurassic rocks, western interior United States—a preliminary survey: U.S. Geological Survey Professional Paper 1035–A, 29 p.

Poole, F.G., and Claypool, G.E., 1984, Petroleum source-rock potential and crude-oil correlation in the Great Basin, *in* Woodward, Jane, and others, eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Rocky Mountain Association of Geologists, p. 179–229.

Poole, F.G., and Sandberg, C.A., 1977, Mississippian paleogeography and tectonics of the western United States, *in* Stewart, J.H., and others, eds., Paleozoic Paleogeography of the Western United States, Pacific Coast Paleogeography Symposium 1: Pacific Section, Society of Economic Paleontologists and Mineralogists, p. 67–85.

Poole, F.G., and Stewart, J.H., 1964, Chinle Formation and Glen Canyon Sandstone in northeastern Utah and northwestern Colorado: U.S. Geological Survey Professional Paper 501–D, p. D30–D39.

Rawson, R.R., and Turner-Peterson, C.E., 1979, Marine-carbonate, sabkha, and eolian facies transitions within the Permian Toroweap Formation, northern Arizona, *in* Baars, D.L., ed., Permianland: Four Corners Geological Society, 9th field conference Guidebook, p. 87–99.

Rigby, J.K., and Clark, D.L., 1962, Devonian and Mississippian Systems in central Utah: Brigham Young University Geology Studies, v. 9, part 1, p. 17–25.

Ryder, R.T., Fouch, T.D., and Elison, J.H., 1976, Early Tertiary sedimentation in the western Uinta basin, Utah: Geological Society of America Bulletin, v. 87, no. 4, p. 496–512.

Ryer, T.A., 1977, Age of Frontier Formation in north-central Utah: American Association of Petroleum Geologists Bulletin, v. 61, no. 1, p. 112–116.

Ryer, T.A., and McPhillips, Maureen, 1983, Early Late Cretaceous paleogeography of east/central Utah *in* Reynolds, M.W. and Dolly, E.D., eds., Mesozoic Paleogeography of the west-central United States: Society of Economic Paleontologists and Mineralogists, Rocky Mountain Paleogeography Symposium 2, p. 253–272.

Sandberg, C.A., and Gutschick, R.C., 1979, Guide to conodont biostratigraphy of Upper Devonian and Mississippian rocks along the Wasatch front and Cordilleran hinge line, Utah, *in* Sandberg, C.A., and Clark, D.L., eds., Conodont biostratigraphy of the Great Basin and Rocky Mountains: Brigham Young University Geology Studies, v. 26, part 3, p. 107–134.

———1984, Distribution, microfauna, and source-rock potential of Mississippian Delle Phosphatic Member of Woodman Formation and equivalents, Utah and adjacent states, *in* Woodward, Jane, and others, eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Rocky Mountain Association of Geologists, p. 135–178.

Sandberg, C.A., Gutschick, R.C., Johnson, J.G., Poole, F.G., and Sando, W.J., 1982, Middle Devonian to Late Mississippian geologic history of the Overthrust Belt region, western U.S., *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 2, p. 691–719.

Sanderson, G.A., and Verville, G.J., 1990, Fusulinid zonation of the General Petroleum no. 45–5–G core, Emery County, Utah: The Mountain Geologist, v. 27, no. 4, p. 131–136.

Sando, W.J., and Dutro, J.T., Jr., 1960, Stratigraphy and coral zonation of the Madison Group and Brazer Dolomite in northeastern Utah, western Wyoming, and southwestern Montana, *in* McGookey, D.P., and Miller, D.N., Jr., eds., Overthrust Belt of southwestern Wyoming and adjacent areas: Wyoming Geological Association 15th Annual Field Conference Guidebook, p. 117–126.

Sando, W.J., Dutro, J.T., Jr., and Gere, W.L., 1959, Brazer Dolomite (Mississippian), Randolph quadrangle, northeast Utah: American Association of Petroleum Geologists Bulletin, v. 43, no. 12, p. 2741–2769.

Schlumberger, 1972, Log Interpretation, volume 1, Principles: Schlumberger, New York, 113 p.

Schlumberger, 1984, Log Interpretation Chart:, Schlumberger, Well Services, U.S.A., 106 p.

Schwans, Peter, 1988, Depositional response of Pigeon Creek Formation, Utah, to initial fold-thrust belt deformation in a differentially subsiding foreland basin, *in* Schmidt, C.J., and

Perry, W.J., Jr., eds., Interaction of the Rocky Mountain foreland and Cordilleran thrust belt: Geological Society of America Memoir 171, p. 531–556.
Spieker, E.M., 1946, Late Mesozoic and Early Cenozoic history of central Utah: U.S. Geological Survey Professional Paper 205–D, p. 117–161.
———1949, The transition between the Colorado Plateau and the Great Basin in central Utah: Guidebook to the geology of Utah, no. 4, Utah Geological Society, 106 p.
Spreng, W.C., 1979, Upper Devonian and Lower Mississippian strata on the flanks of the western Uinta Mountains, Utah: Brigham Young University Geology Studies, v. 26, part 2, p. 67–79.
Sprinkel, D.A., 1982, Twin Creek Limestone-Arapien Shale relations in central Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 169–179.
Sprinkel, D.A., and Waanders, G.L., 1984, Correlation of Twin Creek Limestone with Arapien Shale in Arapien Embayment, Utah—Preliminary appraisal [abs.]: American Association of Petroleum Geologist Bulletin, v. 68, no. 7, p. 950.
Sprinkel, D.A., Weiss, M.P., and Fleming, R.W., 1992, Stratigraphic reinterpretation of a synorogenic unit of late Early Cretaceous age, Sevier orogenic belt, central Utah [abs.]: Geological Society of America Abstracts with Programs, v. 24, no. 6, p. 63.
Standlee, L.A., 1982, Structure and stratigraphy of Jurassic rocks in central Utah: Their influence on tectonic development of the Cordilleran foreland thrust belt, *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, p. 357–382.
Stanley, K.O., and Collinson, J.W., 1979, Depositional history of Paleocene-lower Eocene Flagstaff Limestone and coeval rocks, central Utah: American Association of Petroleum Geologists Bulletin, v. 63, no. 3, p. 311–323.
Stokes, W.L., 1944, Morrison and related deposits in and adjacent to the Colorado Plateau: Geological Society of America Bulletin, v. 55, no. 8, p. 951–992.
———1952, Lower Cretaceous in Colorado Plateau: American Association of Petroleum Geologists Bulletin, v. 36, no. 9, p. 1766–1776.
———1959, Jurassic rocks of the Wasatch Range and vicinity, *in* Williams, N.C., ed., Wasatch and Uinta Mountains: Intermountain Association of Petroleum Geologists, 10th Annual Field Conference guidebook, p. 109–114.
———1972, Stratigraphic problems of the Triassic and Jurassic sedimentary rocks of central Utah, *in* Baer, J.L., and Callaghan, Eugene, eds., Plateau-Basin and Range transition zone: Utah Geological Association Publication 2, p. 21–27.
———1976, What is the Wasatch line?, *in* Hill, J.G., ed., Symposium on geology of the Cordilleran hinge line: Rocky Mountain Association of Petroleum Geologists, p. 11–25.
———1986, Geology of Utah: Utah Museum of Natural History Occasional Paper Number 6, and Utah Geological and Mineral Survey Miscellaneous Publication S, 280 p.
Sweet, W.C., 1979, Late Ordovician conodonts and biostratigraphy of the western Midcontinent Province: Brigham Young University Geology Studies, v. 26, part 3, p. 45–86.
Tisoncik, D.D., 1984, Regional lithostratigraphy of the Phosphoria Formation in the Overthrust Belt of Wyoming, Utah, and Idaho, *in* Woodward, Jane, and óthers, eds., Hydrocarbon source rocks of the greater Rocky Mountain region: Rocky Mountain Association of Geologists, p. 295–320.
Tschudy, R.H., Tschudy, B.D., and Craig, L.C., 1984, Palynological evaluation of Cedar Mountain and Burro Canyon Formations, Colorado Plateau: U.S. Geological Survey Professional Paper 1281, 24 p.
Villien, Alain, and Kligfield, R.M., 1986, Thrusting and synorogenic sedimentation in central Utah, *in* Peterson, J.A., ed., Paleotectonics and sedimentation in the Rocky Mountain region: American Association of Petroleum Geologists Memoir 41, p. 281–306.
Weiss, M.P., 1982, Relation of the Crazy Hollow Formation to the Green River Formation, central Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 285–289.
———1990, Geologic map of the Sterling 7-minute quadrangle, Sanpete County, Utah: Utah Geological and Mineral Survey Open-File Report 195, scale 1:24,000.
Weiss, M.P., and Roche, M.G., 1988, The Cedar Mountain Formation (Lower Cretaceous) in the Gunnison Plateau, central Utah, *in* Schmidt, C.J., and Perry, W.J., Jr., eds., Interaction of the Rocky Mountain foreland and Cordilleran thrust belt: Geological Society of America Memoir 171, p. 557– 569.
Welsh, J.E., and Bissell, H.J., 1979, The Mississippian and Pennsylvanian (Carboniferous) systems in the United States–Utah: U.S. Geological Survey Professional Paper 1110–M–DD, p. Y1–Y35.
Welsh, J.E., Stokes, W.L., and Wardlaw, B.R., 1979, Regional stratigraphic relationships of the Permian "Kaibab" or Black Box Dolomite of the Emery high, central Utah, *in* Baars, D.L., ed., Permianland: Four Corners Geological Society Guidebook, 9th Field Conference, p. 143–149.
West, Judy, and Lewis, Helen, 1982, Structure and palinspastic reconstruction of the Absaroka thrust, Anschutz Ranch area, Utah and Wyoming, *in* Powers, R.B., ed., Geologic studies of the Cordilleran thrust belt: Rocky Mountain Association of Geologists, v. 2, p. 633–639.
Willis, G.C., 1986, Geologic Map of the Salina quadrangle, Sevier County, Utah: Utah Geological and Mineral Survey Map 83, 20 p., scale 1:24,000.
———1988, Geologic Map of the Aurora quadrangle, Sevier County, Utah: Utah Geological and Mineral Survey Map 112, 21 p., scale 1:24,000.
———1991, Geologic map of the Redmond Canyon quadrangle, Sanpete and Sevier counties, Utah: Utah Geological Survey Map 138, 17 p., scale 1:24,000.
Witkind, I.J., 1982, Salt diapirism in central Utah, *in* Nielson, D.L., ed., Overthrust Belt of Utah: Utah Geological Association Publication 10, p. 13–30.
———1988, Geologic map of the Huntington 30′×60′ quadrangle, Carbon, Emery, Grand, and Uintah counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I–1764, scale 1:100,000.
Witkind, I.J., and Hardy, C.T., 1983, The Arapien Shale of central Utah—A dilemma in stratigraphic nomenclature: U.S. Geological Survey Bulletin 1537–A, p. A5–A20.
Witkind, I.J., and Marvin, R.F., 1989, Significance of new potassium-argon ages from the Goldens Ranch and Moroni Formations, Sanpete-Sevier Valley area, central Utah:

Geological Society of America Bulletin, v. 101, no. 4, p. 534–548.

Witkind, I.J., and Page, W.R., 1983, Geologic Map of the Thistle area, Utah County, Utah: Utah Geological and Mineral survey Map 69, scale 1:24,000.

———1984, Origin and significance of the Wasatch and Valley Mountains monoclines, Sanpete/Sevier Valley area, central Utah: The Mountain Geologist, v. 21, no. 4, p. 143–156.

Witkind, I.J., Standlee, L.A., and Maley, K.F., 1986, Age and correlation of Cretaceous rocks previously assigned to the Morrison(?) Formation, Sanpete- Sevier Valley area, central Utah: U.S. Geological Survey Bulletin 1584, 9 p.

Witkind, I.J., Weiss, M.P., and Brown, T.L., 1987, Geologic map of the Manti 30′×60′ quadrangle, Carbon, Emery, Juab, Sanpete, and Sevier counties, Utah: U.S. Geological Survey Miscellaneous Investigations Map I–1631, scale 1:100,000.

APPENDIX

The appendix contains the well information used to construct the cross sections. It gives the data-point number used to locate the well on the cross sections and in figure 4, the operator's name (OPERATOR), the well name (WELL NAME), the well location (by section, township, and range) (LOCATION), the county in which the well is located (COUNTY), the elevation of the Kelly Bushing (KB), and the total depth of penetration (TD). The appendix also lists names of formations identified in the well (FORMATION), the depth at which the formation was picked from well logs (TOPS), formation thickness (THICK), and elevation of the formation relative to sea level (SUBSEA). All depths (negative numbers), elevations, and thicknesses are reported in feet.

The first formation listed for each well is the surface formation mapped at that location. It is indicated with a "TOP" of zero. Formations noted with the word "ESTIMATED" by the formation name or that may have a "TOP" of zero, indicate that I was uncertain about the exact location of the subsurface contact or that the well logs available to me were not run over that interval.

Table 1. Data points (DP) with references used to identify stratigraphic units and constrain stratigraphic nomenclature and ages

Area	DP	Operator	Well Name	Location	County	References
Absaroka thrust plate	1	Amoco	Island Ranching D-1	T. 4 N., R. 7 E., sec. 14	Summit	Armstrong and Oriel, 1965; Baars, 1972; Crittenden, 1963, 1974; Foster, 1972; Gutschick and others, 1980; Hale, 1960a, 1960b; Hintze, 1988; Imlay, 1967, 1980; Jacobson and Nichols, 1982; Lamerson, 1982; Lochman-Balk, 1972,1976; Maughan, 1984; McGookey and others, 1972; Mullens, 1971; Nichols and others, 1982; Nichols and Jacobson, 1982a, 1982b; Oriel and Platt, 1980; Ott, 1980; Pipiringos and Imlay, 1979; Pipiringos and O'Sullivan, 1978; Poole and Sandberg, 1977; Poole and Stewart, 1964; Ryer, 1977; Sandberg and others, 1982; Sando and others, 1959; Sando and Dutro, 1960; Stokes, 1986; Sweet, 1979; Tisoncik, 1984; Welsh and Bissell, 1979; West and Lewis, 1982
	2	Anschutz	Anschutz Ranch 3-1	T. 3 N., R. 7 E., sec. 3	Summit	
	3	American Quasar	UPRR 27-1	T. 2 N., R. 6 E., sec. 27	Summit	
	4	American Quasar	UPRR 35-1	T. 2 N., R. 6 E., sec. 35	Summit	
	5	Exxon	UPRR 9-1	T. 1 N., R. 6 E., sec. 9	Summit	
	6	Amoco	Rockport Reservoir 1	T. 1 N., R. 5 E., sec. 21	Summit	
Western projection of Uinta Mountains	7		Surface control		Summit and Wasatch	Bryant and Nichols, 1988; Bryant and others, 1989a, 1989b; Bromfield and Crittenden, 1971; Bromfield and others, 1970; Crittenden and others, 1966; Franczyk and others, 1992; Hintze, 1988; Spreng, 1979; Stokes, 1959, 1986
Charleston - Nebo thrust plate	8	Placid	Daniels Land 1	T. 5 S., R. 5 E., sec. 5	Wasatch	Baars, 1972; Baker, 1976; Biek, 1991; Bissell, 1962; Bryant and Nichols, 1988; Bryant and others, 1989a, 1989b; Fouch, 1976; Fouch and others, 1982, 1983; Franczyk and others, 1992; Greenhalgh, 1980; Gutschick and others, 1980; Hintze, 1988; Imlay, 1967, 1980; Lawton, 1982, 1985; Lochman-Balk, 1972, 1976; McGookey and others, 1972; Nichols and Bryant, 1986a, 1986b; Pipiringos and O'Sullivan, 1978; Poole and Sandberg, 1977; Poole and Stewart, 1964; Poole and Claypool, 1984; Rigby and Clark, 1962; Ryder and others, 1976; Sandberg and Gutschick, 1979, 1984; Sandberg and others, 1982; Spreng, 1979; Sprinkel and Waanders, 1984; Stokes, 1986; Witkind and Page, 1983
	9	Amoco	Strawberry River 1	T. 4 S., R. 12 W., sec. 26	Wasatch	
	10	Exxon	Strawberry Reservoir 1	T. 4 S., R. 11 W., sec. 30	Wasatch	
	11	Exxon	Buffalo Canyon Unit 1	T. 5 S., R. 12 W., sec. 13	Wasatch	
	13	Union Oil	Federal 1-G-24	T. 11 S., R. 4 E., sec. 24	Utah	
	14	Union Oil	Federal 1-J-9	T. 11 S., R. 4 E., sec. 9	Utah	
Zone of imbricate thrusts and diapirism	15	Phillips	Neilson-Seagar 1	T. 13 S., R. 2 E., sec. 1	Sanpete	Auby, 1991; Baars, 1972; Banks, 1991, Biek, 1991; Blakey, 1974; Bryant and others, 1989a, 1989b; Fouch and others, 1982, 1983; Franczyk and others, 1992; Gilliland, 1963; Gutschick and others, 1980; Hardy, 1952; Hintze, 1988; Imlay, 1967, 1980; Irwin, 1971, Jefferson, 1982; Kowallis and Heaton, 1987; Lawton, 1982, 1983, 1985, 1986; Lochman-Balk, 1972, 1976; Mattox, 1987, 1989; Marcantel and Weiss, 1968; McGookey and others, 1972; Oviatt, 1992; Pipiringos and O'Sullivan, 1978; Poole and Sandberg, 1977; Rawson and Turner-Peterson, 1979; Rigby and Clark, 1962; Sandberg and Gutschick, 1979, 1984; Sandberg and others, 1982; Spieker, 1946, 1949; Sprinkel, 1982; Sprinkel and Waanders, 1984; Standlee, 1982; Stanley and Collinson, 1979; Stokes, 1972, 1986; Tschudy and others, 1984; Villien and Kligfield, 1986; Weiss, 1982, 1990; Weiss and Roche, 1988; Welsh and Bissell, 1979; Welsh and others, 1979; Willis, 1986, 1988, 1991; Witkind, 1982; Witkind and Hardy, 1983; Witkind and Page, 1983, 1984; Witkind and others, 1986, 1987; Witkind and Marvin, 1989
	16	Placid	WXC-Howard 1A	T. 14 S., R. 1 W., sec. 5	Juab	
	17	Placid	WXC-Howard 2	T. 14 S., R. 1 W., sec. 5	Juab	
	18	Placid	WXC-State 1	T. 15 S., R. 1½ W., sec. 36	Juab	
	19	Placid	WXC-Barton 1	T. 16 S., R. 1 W., sec. 32	Juab	
	20	Amoco	Sevier Bridge Unit 1	T. 16 S., R. 1 W., sec. 11	Juab	
	21	Dixel	Gunnison State 1	T. 16 S., R. 1 E., sec. 15	Juab	
	22	Mobil	Larson Unit 1	T. 17 S., R. 2 E., sec. 1	Sanpete	
	23	Phillips	Price N-1	T. 15 S., R. 3 E., sec. 29	Sanpete	
	24	Tennessee Gas	Irons 1	T. 15 S., R. 3 E., sec. 16	Sanpete	
	25	Hanson Oil	Moroni 1AX	T. 15 S., R. 3 E., sec. 14	Sanpete	
Wasatch Plateau - San Rafael Swell	12	Energy Reserves	Indianola Unit Well 1	T. 11 S., R. 5 E., sec. 27	Utah	Baars, 1972; Blakey, 1974; Fouch and others, 1982, 1983; Franczyk and others, 1992; Gilluly, 1929; Hintze, 1988; Imlay, 1967, 1980; Irwin, 1971; Kowallis and Heaton, 1987; Lawton, 1983, 1986; Lochman-Balk, 1972, 1976; Loope and others, 1990; McGookey and others, 1972; Pipiringos and O'Sullivan, 1978; Rawson and Turner-Peterson, 1979; Ryer and McPhillips, 1983; Sanderson and Verville, 1990; Spieker, 1946, 1949; Stokes, 1944, 1986; Tschudy and others, 1984; Welsh and Bissell, 1979; Welsh and others, 1979; Witkind, 1988; Witkind and others, 1987
	26	Phillips	USA E-1	T. 19 S., R. 3 E., sec. 27	Sanpete	
	27		Surface control		Emery	
	28	BWAB	Orangeville Unit 1	T. 19 S., R. 7 E., sec. 1	Emery	
	29	Pan American	Ferron Unit 1	T. 20 S., R. 7 E., sec. 21	Emery	
	30	Husky Oil	Castledale-Dennison 1	T. 19 S., R. 8 E., sec. 10	Emery	
	31	Hammon	USA Federal 8-1	T. 19 S., R. 9 E., sec. 8	Emery	

Table 2. Stratigraphic thicknesses of units in the Absaroka thrust plate

Age*	Formation	Data point					
		1	2	3	4	5	6
		Thickness (ft)					
T	Wasatch Formation	----	300	1790	1673	3450	----
TK	Evanston Formation	----	----	1352	1644	1660	----
K	Echo Canyon Conglomerate	----	----	----	----	----	----
K	Henefer Formation	----	----	----	----	----	----
K	Frontier Formation	1191	1460	1724	718	980	2000
K	Aspen Shale	320	320	368	325	210	300
K	Kelvin Formation	3329	3452	3622	3945	3440	6050
J	Stump Sandstone	525	404	370	418	360	256
J	Preuss Sandstone	1283	124	1382	1690	2035	1696
J	Twin Creek Limestone	1800	1453	1426	1405	1733	1813
J	Gypsum Spring Member of Twin Creek Limestone	117	89	66	69	47	63
J	Nugget Sandstone	1209	1106	88	1473	1268	96
TR	Upper Member of Ankareh Formation	267	250	----	180	----	----
TR	Gartra(?) Member of Ankareh Formation	50	52	----	60	----	----
TR	Mahogany Member of Ankareh Formation	834	925	----	720	----	----
TR	Thaynes Formation	1519	1520	----	1324	----	----
TR	Woodside Shale	851	453	----	338	----	----
TR	Dinwoody Formation	245	442	----	----	----	----
P	Phosphoria Formation	908	1570	----	----	----	----
PIP	Weber Sandstone	832	50	----	----	----	----
IP	Morgan Formation	145	----	----	----	----	----
IP	Round Valley Limestone	439	----	----	----	----	----
M	Brazer Dolomite	974	----	----	----	----	----
M	Lodgepole Limestone	977	----	----	----	----	----
D	Three Forks Formation	271	----	----	----	----	----
D	Jefferson Formation	264	----	----	----	----	----
O	Bighorn Dolomite	180	----	----	----	----	----

* T, Tertiary; TK, Tertiary and Cretaceous; K, Cretaceous; J, Jurassic; TR, Triassic; P, Permian; PIP, Permian and Pennsylvanian; IP, Pennsylvanian; M, Mississippian; D, Devonian; O, Ordovician.

Table 3. Stratigraphic thicknesses of units near the western projection of the Uinta Mountains and in the Charleston-Nebo thrust plate

		Data point				
		7	8	9	10	11
Age*	Formation	Thickness (ft)				
T	Keetley Volcanics	1500	----	----	----	----
T	Duchesne River Formation	----	----	----	980	----
T	Green River Formation	----	----	4360	4120	5496
T	North Horn Formation	----	----	1960	2220	2864
K	Frontier Formation	1500	----	----	----	----
K	Aspen Shale	500	----	----	----	----
K	Kelvin Formation	3000	----	----	----	----
KJ	Morrison Formation	300	----	----	----	----
J	Stump Sandstone	150	----	----	----	----
J	Preuss Sandstone	1100	----	----	----	----
J	Arapien(?) Shale	----	473	----	----	----
J	Twin Creek Limestone	1357	671	----	----	----
J	Gypsum Springs Mbr., Twin Creek Limestone	22	----	----	----	----
J	Nugget Sandstone	1450	1306	----	----	----
TR	Upper Member of Ankareh Formation	550	380	----	----	----
TR	Gartra(?) Member of Ankareh Formation	250	100	----	----	----
TR	Mahogany Member of Ankareh Formation	1050	968	----	----	----
TR	Thaynes Formation	1530	1196	----	----	739
TR	Woodside Shale	450	462	----	----	1032
P	Park City Formation	650	624	----	----	1173
PIP	Weber Sandstone	1500	222	----	----	196
PIP	Oquirrh Formation	----	10608	6018	9500	----
IP	Round Valley Limestone	400	----	----	----	----
IPM	Manning Canyon Shale	----	312	----	----	----
M	Doughnut Formation	----	----	----	----	----
M	Humbug Formation	----	----	----	----	----
M	Brazer Dolomite	900	----	----	----	----
M	Deseret Limestone	500	----	----	----	----
M	Gardison Limestone	350	----	----	----	----
MD	Fitchville Formation	400	----	----	----	----
--C	Maxfield Limestone	----	----	----	----	----
--C	Ophir Shale	350	----	----	----	----
--C	Tintic Quartzite	850	----	----	----	----

* Symbols same as on table 2; additional symbols are KJ, Cretaceous and Jurassic; IPM, Pennsylvanian and Mississippian; MD, Mississippian and Devonian; and --C, Cambrian.

Table 4. Stratigraphic thicknesses of units in the zone of imbricate thrusts and diapirism

		Data point												
		13	14	15	16	17	18	19	20	21	22	23	24	25
Age*	Formation	Thickness (ft)												
T	Goldens Ranch Formation	----	----	----	----	----	----	1641	----	----	----	----	----	----
T	Crazy Hollow Formation	----	----	----	----	----	----	----	----	----	----	----	----	300
T	Green River Formation	----	----	----	----	----	796	1076	1280	----	----	1123	1625	1355
T	Colton Formation	----	----	----	----	----	414	----	----	----	----	392	415	425
T	Flagstaff Limestone	----	----	475	----	----	295	----	----	1020	270	200	225	220
TK	North Horn Formation	----	708	820	3810	4078	1840	----	----	2204	810	1330	2815	2780
K	Indianola Group (undivided)	2245	1064	----	----	----	581	1733	----	3487	----	----	----	----
K	Sixmile Canyon Formation	----	----	8207	----	----	----	----	----	----	----	----	1005	3990
K	Funk Valley Formation	----	----	----	----	----	----	----	----	----	912	925	2655	2480
K	Allen Valley Shale	----	----	----	----	----	----	----	----	----	202	397	535	520
K	Sanpete Formation	----	----	----	----	----	----	----	----	----	466	821	255	302
K	unnamed conglomerate	----	----	----	1078	1099	922	767	----	2033	985	702	----	733
K	Cedar Mountain Formation	----	----	----	----	----	----	205	----	862	1686	670	----	595
J	Twist Gulch Formation	----	----	----	----	----	----	308	----	1162	1595	1545	----	873
J	Arapien Shale	5159	3114	----	4342	4117	2733	1820	3489	3668	6437	3762	----	2737
J	Twin Creek Limestone	----	584	----	1140	1056	959	560	421	309	----	----	----	540
J	Gypsum Springs Member of Twin Creek Limestone	----	----	----	274	212	344	162	45	----	----	----	----	----
J	Navajo Sandstone	----	1155	----	1450	202	975	1246	1241	1088	----	----	----	685
TR	Petrified Forest Member of Chinle Formation	----	----	----	56	----	----	367	538	----	----	----	----	25
TR	Moss Back Member of Chinle Formation	----	----	----	----	----	----	162	113	----	----	----	----	70
TR	Moenkopi Formation	----	----	----	----	----	----	1990	1593	----	----	----	----	1870
P	Black Box Dolomite	----	----	----	----	----	----	235	----	----	----	----	----	340
P	Toroweap Formation	----	----	----	----	----	----	1083	----	----	----	----	----	424
M	Humbug Formation	----	----	----	----	----	----	87	----	----	----	----	----	----
M	Deseret Limestone	----	----	----	----	----	----	920	----	----	----	----	----	----
M	Gardison Limestone	----	----	----	----	----	----	584	----	----	----	----	----	----
MD	Fitchville Formation	----	----	----	----	----	----	246	----	----	----	----	----	----
D	Pinyon Peak Limestone	----	----	----	----	----	----	187	----	----	----	----	----	----
--C	Cambrian(?) rocks, undivided	----	----	----	----	----	----	848	----	----	----	----	----	----

* Symbols same as on tables 2 and 3.

Table 5. Stratigraphic thicknesses of units in Wasatch Plateau and northwestern margin of the San Rafael Swell

		Data points						
		12	26	27	28	29	30	31
Age*	Formation	Thickness (ft)						
T	Flagstaff Limestone	1000	----	1000	----	----	----	----
TK	North Horn Formation	3961	1205	300	----	----	----	----
K	Price River Formation	1189	951	1200	----	----	----	----
K	Castlegate Sandstone	640	407	500	----	----	----	----
K	Blackhawk Formation	980	942	1000	----	----	----	----
K	Star Point Sandstone	267	654	350	----	----	----	----
K	upper part Blue Gate Mbr., Mancos Shale	221	396	1000	----	----	----	----
K	Emery Sandstone Mbr., Mancos Shale	1882	2135	285	----	----	----	----
K	lower part Blue Gate Mbr., Mancos Shale	1050	1402	200	218	798	125	----
K	Ferron Sandstone Mbr., Mancos Shale	660	712	340	306	312	288	----
K	Tununk Mbr., Mancos Shale	326	579	550	586	568	513	----
K	Dakota Sandstone	559	670	30	20	62	149	----
K	unnamed conglomerate	269	219	----	----	----	----	----
K	Cedar Mountain Formation	654	690	500	493	445	13	755
KJ	Morrison Formation	----	----	350	418	304	----	445
J	Summerville Formation	774	555	----	350	406	----	260
J	Curtis Formation	194	172	----	173	90	----	160
J	Entrada Sandstone	----	----	----	680	800	----	650
J	Twist Gulch Formation	1212	504	----	----	----	----	----
J	upper part of Carmel Formation	----	----	----	590	497	----	168
J	lower part of Carmel Formation	----	----	----	259	523	----	462
J	Arapien Shale	588	968	----	----	----	----	----
J	Twin Creek Limestone	527	570	----	----	----	----	----
J	Navajo Sandstone	96	619	----	487	610	----	433
J	Kayenta Formation	----	270	----	162	210	----	247
J	Wingate Sandstone	----	330	----	344	267	----	270
TR	Petrified Forest Mbr., Chinle Formation	----	300	----	98	138	----	105
TR	Moss Back Mbr., Chinle Formation	----	78	----	80	123	----	188
TR	Moenkopi Formation	----	1467	----	1120	997	----	897
P	Black Box Dolomite	----	183	----	134	150	----	75
P	White Rim Sandstone	----	479	----	76	443	----	480
M	Redwall Limestone	----	755	----	----	369	----	305
D	Ouray Limestone	----	116	----	----	143	----	67
D	Elbert Formation	----	449	----	----	385	----	248
--C	Lynch Dolomite	----	639	----	----	512	----	----
--C	Maxfield Limestone	----	677	----	----	568	----	----
--C	Ophir Formation	----	231	----	----	211	----	----
--C	Tintic Quartzite	----	126	----	----	91	----	----

* Symbols same as on tables 2 and 3.

APPENDIX

The appendix contains the well information used to construct the cross sections. It gives the data-point number used to locate the well on the cross sections and in figure 4, the operator's name (OPERATOR), the well name (WELL NAME), the well location (by section, township, and range) (LOCATION), the county in which the well is located (COUNTY), the elevation of the Kelly Bushing (KB), and the total depth of penetration (TD). The appendix also lists names of formations identified in the well (FORMATION), the depth at which the formation was picked from well logs (TOPS), formation thickness (THICK), and elevation of the formation relative to sea level (SUBSEA). All depths (negative numbers), elevations, and thicknesses are reported in feet.

The first formation listed for each well is the surface formation mapped at that location. It is indicated with a "TOP" of zero. Formations noted with the word "ESTIMATED" by the formation name or that may have a "TOP" of zero, indicate that I was uncertain about the exact location of the subsurface contact or that the well logs available to me were not run over that interval.

APPENDIX

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
1	Amoco	Island Ranching D-1	NW¼NW¼ sec. 14,	Summit	7401	18810	Frontier Formation	0	1191	7401
			T. 4 N., R. 7 E.				Aspen Shale	1191	320	6210
							Kelvin Formation	1511	3329	5890
							Stump Sandstone	4840	525	2561
							Preuss Sandstone	5365	1283	2036
							Twin Creek Limestone	6648	1800	753
							Gypsum Spring Member of Twin Creek Limestone	8448	117	-1047
							Nugget Sandstone	8565	1209	-1164
							Upper Member of Ankareh Formation	9774	267	-2373
							Gartra Member of Ankareh Formation	10041	50	-2640
							Mahogany Member Ankareh Formation	10091	834	-2690
							Thaynes Formation	10925	1519	-3524
							Woodside Shale	12444	851	-5043
							Dinwoody(?) Formation	13295	245	-5894
							Phosphoria Formation	13540	908	-6139
							Weber Sandstone	14448	832	-7047
							Morgan Formation	15280	145	-7879
							Round Valley Limestone	15425	439	-8024
							Brazer Dolomite	15864	974	-8463
							Lodgepole Limestone	16838	977	-9437
							Three Forks Formation	17815	271	-10414
							Jefferson Formation	18086	264	-10685
							Bighorn Dolomite	18350	180	-10949
							Thrust	18530	0	-11129
							Aspen(?) Shale	18530	280	-11129
							TD	18810		-11409
2	Anschutz	Anschutz Ranch 3-1	NW¼NW¼ sec. 3,	Summit	7222	13970	Wasatch Formation	0	300	7222
			T. 3 N., R. 7 E.				Frontier Formation (estimated top)	300	1460	6922
							Aspen Shale	1760	320	5462
							Kelvin Formation	2080	3452	5142
							Stump Sandstone	5532	404	1690
							Preuss Sandstone	5936	124	1286
							Twin Creek Limestone	6060	1453	1162
							Gypsum Spring Member of Twin Creek Limestone	7513	89	-291
							Nugget Sandstone	7602	1106	-380
							Upper Member of Ankareh Formation	8708	250	-1486
							Gartra Member of Ankareh Formation (estimated top)	8958	52	-1736
							Mahogany Member Ankareh Formation (estimated top)	9010	925	-1788
							Thaynes Formation	9935	1520	-2713
							Woodside Shale	11455	453	-4233
							Dinwoody(?) Formation	11908	442	-4686
							Phosphoria Formation	12350	1570	-5128

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Weber Sandstone	13920	50	-6698
							TD	13970		-6748
3	American Quasar	UPRR 27-1	SE¼SE¼ sec. 27,	Summit	7878	12188	Wasatch Formation	0	1790	7878
			T. 2 N., R. 6 E.				Evanston Formation (estimated top)	1790	1352	6088
							Frontier Formation	3142	1724	4736
							Aspen Shale	4866	368	3012
							Kelvin Formation	5234	3622	2644
							Stump Sandstone	8856	370	-978
							Preuss Sandstone	9226	1382	-1348
							Twin Creek Limestone	10608	1426	-2730
							Gypsum Spring Member of Twin Creek Limestone	12034	66	-4156
							Nugget Sandstone	12100	88	-4222
							TD	12188		-4310
4	American Quasar	UPRR 35-1	SE¼NW¼ sec. 35,	Summit	7300	17053	Wasatch Formation	0	1673	7300
			T. 2 N., R. 6 E.				Evanston Formation	1673	1644	5627
							Frontier Formation	3317	718	3983
							Aspen Shale	4035	325	3265
							Kelvin Formation	4360	3945	2940
							Stump Sandstone	8305	418	-1005
							Preuss Sandstone	8723	1690	-1423
							Twin Creek Limestone	10413	1405	-3113
							Gypsum Spring Member of Twin Creek Limestone	11818	69	-4518
							Nugget Sandstone	11887	1473	-4587
							Upper Member of Ankareh Formation	13360	180	-6060
							Gartra Member of Ankareh Formation	13540	60	-6240
							Mahogany Member Ankareh Formation	13600	720	-6300
							Thaynes Formation	14320	1324	-7020
							Woodside Shale	15644	338	-8344
							Thrust	15982	0	-8682
							Aspen Shale	15982	358	-8682
							Kelvin Formation	16340	713	-9040
							TD	17053		-9753
5	Exxon	UPRR 9-1	NE¼SW¼ sec. 9,	Summit	8201	15183	Wasatch Formation	0	3450	8201
			T. 1 N., R. 6 E.				Evanston Formation (estimated top)	3450	1660	4751
							Frontier Formation	5110	980	3091
							Aspen Shale	6090	210	2111
							Kelvin Formation	6300	3440	1901
							Stump Sandstone	9740	360	-1539
							Preuss Sandstone	10100	2035	-1899
							Twin Creek Limestone	12135	1733	-3934
							Gypsum Spring Member of Twin Creek Limestone	13868	47	-5667
							Nugget Sandstone	13915	1268	-5714
							TD	15183		-6982
6	Amoco	Rockport Reservoir 1	SW¼SE¼ sec. 21,	Summit	6715	12274	Frontier Formation	0	2000	6715
			T. 1 N., R. 5 E.				Aspen Shale	2000	300	4715

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Kelvin Formation	2300	6050	4415
							Stump Sandstone	8350	256	-1635
							Preuss Sandstone	8606	1696	-1891
							Twin Creek Limestone	10302	1813	-3587
							Gypsum Spring Member of Twin Creek Limestone	12115	63	-5400
							Nugget Sandstone	12178	96	-5463
							TD	12274		-5559
7	Surface control	USGS Map GQ-852, GQ-864								
8	Placid	Daniels Land 1	NW¼NW¼ sec. 5,	Wasatch	7575	17322	Oquirrh Formation	0	10608	7575
			T. 5 S., R. 5 E.				Manning Canyon Shale	10608	312	-3033
							Thrust	10920	0	-3345
							Arapien(?) Shale	10920	473	-3345
							Twin Creek Limestone	11393	671	-3818
							Nugget Sandstone	12064	1306	-4489
							Upper Member of Ankareh Formation	13370	380	-5795
							Gartra Member of Ankareh Formation	13750	100	-6175
							Mahogany Member Ankareh Formation	13850	968	-6275
							Thaynes Formation	14818	1196	-7243
							Woodside Shale	16014	462	-8439
							Park City Formation	16476	624	-8901
							Weber Sandstone	17100	222	-9525
							TD	17322		-9747
9	Amoco	Strawberry River 1	NE¼NE¼ sec. 26,	Wasatch	8018	12338	Green River Formation	0	4360	8018
			T. 4 S., R. 12 W.				North Horn Formation	4360	1960	3658
							Oquirrh Formation	6320	6018	1698
							TD	12338		-4320
10	Exxon	Strawberry Reservoir 1	E½SW¼ sec. 30,	Wasatch	7929	19993	Duchesne River Formation	0	980	7929
			T. 4 S., R. 11 W.				Green River Formation	980	4120	6949
							North Horn Formation	5100	2220	2829
							Oquirrh Formation	7320	9500	609
							Thrust	16820	0	-8891
							Woodside Shale (inverted section)	16820	3172	-8891
							Thaynes Formation (inverted section)	19992	1	-12063
							TD	19993		-12064
11	Exxon	Buffalo Canyon Unit 1	NE¼SE¼ sec. 13,	Wasatch	8816	14201	Green River Formation	0	5496	8816
			T. 5 S., R. 12 W.				North Horn Formation	5496	2864	3320
							Woodside Shale	8360	1020	456
							Park City Formation	9380	552	-564
							Thrust	9932	0	-1116
							Thaynes Formation	9932	739	-1116
							Fault	10671	0	-1855

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Woodside Shale	10671	1044	-1855
							Park City Formation	11715	2290	-2899
							Kirkman Limestone	14005	196	-5189
							TD	14201		-5385
12	Energy Reserves	Indianola Unit Well 1	SE¼SW¼ sec. 27,	Utah	9175	17049	Flagstaff Member of Green River Formation	0	1000	9175
	(Sohio)		T. 11 S., R. 5 E.				North Horn Formation (estimated top)	1000	3961	8175
							Price River Formation	4961	1189	4214
							Castlegate Sandstone	6150	640	3025
							Blackhawk Formation	6790	980	2385
							Star Point Sandstone	7770	267	1405
							Upper Part Blue Gate Member of Mancos Shale	8037	221	1138
							Emery Sandstone Member of Mancos Shale	8258	1882	917
							Lower Part Blue Gate Member of Mancos Shale	10140	1050	-965
							Ferron Sandstone Member of Mancos Shale	11190	660	-2015
							Tununk Member of Mancos Shale	11850	326	-2675
							Dakota Sandstone	12176	559	-3001
							Unnamed conglomerate	12735	269	-3560
							Cedar Mountain Formation	13004	654	-3829
							Summerville Formation	13658	774	-4483
							Curtis Formation	14432	194	-5257
							Twist Gulch Formation	14626	1212	-5451
							Arapien Shale	15838	588	-6663
							Twin Creek Limestone	16426	527	-7251
							Navajo Sandstone	16953	96	-7778
							TD	17049		-7874
13	Union Oil	Federal 1-G-24	SW¼NE¼ sec. 24,	Utah	7451	7404	Indianola Group	0	2245	7451
			T. 11 S., R. 4 E.				Arapien Shale	2245	5159	5206
							TD	7404		47
14	Union Oil	Federal 1-J-9	SW¼NE¼ sec. 9,	Utah	6640	6625	North Horn Formation	0	708	6640
			T. 11 S., R. 4 E.				Indianola Group	708	1064	5932
							Arapien Shale	1772	3114	4868
							Twin Creek Limestone	4886	584	1754
							Navajo Sandstone	5470	1155	1170
							TD	6625		15
15	Phillips	Neilson-Seagar 1	SE¼NE¼ sec. 1,	Sanpete	7542	9502	Flagstaff Limestone	0	475	7542
			T. 13 S., R. 2 E.				North Horn Formation	475	820	7067
							Sixmile Canyon Formation	1295	8207	6247
							TD	9502		-1960
16	Placid	WXC-Howard 1A	NE¼NW¼ sec. 5,	Juab	5988	12150	North Horn Formation	0	3810	5988
			T. 14 S., R 1 W.				Unnamed conglomerate	3810	1078	2178
							Arapien Shale	4888	4342	1100
							Twin Creek Limestone	9230	1140	-3242
							Gypsum Spring Member of Twin Creek Limestone	10370	274	-4382
							Navajo Sandstone	10644	1450	-4656
							Petrified Forest Member of Chinle Formation	12094	56	-6106

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							TD	12150		-6162
17	Placid	WXC-Howard 2	NE¼SE¼ sec. 5,	Juab	6291	10764	North Horn Formation	0	4078	6291
			T. 14 S., R. 1 W.				Unnamed conglomerate	4078	1099	2213
							Arapien Shale	5177	4117	1114
							Twin Creek Limestone	9294	1056	-3003
							Gypsum Spring Member of Twin Creek Limestone	10350	212	-4059
							Navajo Sandstone	10562	202	-4271
							TD	10764		-4473
18	Placid	WXC-State 1	NW¼SW¼ sec. 36,	Juab	5201	13894	Green River Formation	0	796	5201
			T. 15 S., R. 1½ W.				Colton Formation	796	414	4405
							Flagstaff Limestone	1210	295	3991
							North Horn Formation	1505	1840	3696
							Indianola Group	3345	581	1856
							Unnamed conglomerate	3926	922	1275
							Arapien Shale	4848	1904	353
							Twin Creek Limestone	6752	999	-1551
							Gypsum Spring Member of Twin Creek Limestone	7751	344	-2550
							Thrust	8095	0	-2894
							Arapien Shale	8095	3561	-2894
							Twin Creek Limestone	11656	919	-6455
							Gypsum Spring Member of Twin Creek Limestone	12575	344	-7374
							Navajo Sandstone	12919	975	-7718
							TD	13894		-8693
19	Placid	WXC-Barton 1	NW¼SE¼ sec. 32,	Juab	5116	21845	Goldens Ranch Formation	0	1641	5116
			T. 16 S., R. 1 W.				Green River Formation	1641	1076	3475
							Indianola Group	2717	1733	2399
							Unnamed conglomerate	4450	767	666
							Cedar Mountain Formation	5217	205	-101
							Twist Gulch Formation	5422	308	-306
							Arapien Shale	5730	1820	-614
							Twin Creek Limestone	7550	560	-2434
							Gypsum Spring Member of Twin Creek Limestone	8110	162	-2994
							Navajo Sandstone	8272	1246	-3156
							Petrified Forest Member of Chinle Formation	9518	367	-4402
							Moss Back Member of Chinle Formation	9885	162	-4769
							Moenkopi Formation	10047	1638	-4931
							Thrust	11685	0	-6569
							Paleozoic	11685	1403	-6569
							Thrust	13088	0	-7972
							Black Box Dolomite (inverted section)	13088	235	-7972
							Black Dragon Member of Moenkopi Formation (inverted)	13323	287	-8207
							Sinbad Limestone Member of Moenkopi Formation (inverted)	13610	572	-8494
							Middle Red Member of Moenkopi Formation (inverted)	14182	408	-9066
							Shnabkaib Member of Moenkopi Formation (inverted)	14590	241	-9474
							Upper Red Member of Moenkopi Formation (inverted)	14831	299	-9715

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Thrust	15130	0	-10014
							Sinbad Limestone Member of Moenkopi Formation	15130	584	-10014
							Thrust	15714	0	-10598
							Upper Red Member of Moenkopi Formation	15714	346	-10598
							Shnabkaib Member of Moenkopi Formation	16060	260	-10944
							Middle Red Member of Moenkopi Formation	16320	310	-11204
							Sinbad Limestone Member of Moenkopi Formation	16630	565	-11514
							Black Dragon Member of Moenkopi Formation	17195	460	-12079
							Black Box Dolomite	17655	235	-12539
							Toroweap Formation	17890	1083	-12774
							Humbug Formation	18973	87	-13857
							Deseret Limestone	19060	920	-13944
							Gardison Limestone	19980	584	-14864
							Fitchville Formation	20564	246	-15448
							Pinyon Peak Limestone	20810	187	-15694
							Cambrian(?)	20997	848	-15881
							TD	21845		-16729
20	Amoco	Sevier Bridge Unit 1	SW¼SE¼ sec. 11,	Juab	5655	11000	Green River Formation	0	1280	5655
			T. 16 S., R. 1 W.				Arapien Shale	1280	3489	4375
							Twin Creek Limestone	4769	421	886
							Gypsum Spring Member of Twin Creek Limestone	5190	45	465
							Navajo Sandstone	5235	1624	420
							Petrified Forest Member of Chinle Formation	6859	611	-1204
							Moss Back Member of Chinle Formation	7470	130	-1815
							Moenkopi Formation	7600	390	-1945
							Thrust	7990	0	-2335
							Navajo Sandstone	7990	857	-2335
							Petrified Forest Member of Chinle Formation	8847	465	-3192
							Moss Back Member of Chinle Formation	9312	95	-3657
							Upper Red Member of Moenkopi Formation	9407	1054	-3752
							Shnabkaib Member of Moenkopi Formation	10461	217	-4806
							Middle Red Member of Moenkopi Formation	10678	310	-5023
							Sinbad Limestone Member of Moenkopi Formation	10988	12	-5333
							TD	11000		-5345
21	Dixel	Gunnison State 1	NE¼NE¼ sec. 15,	Juab	7918	15833	Flagstaff Limestone	0	1020	7918
			T. 16 S., R. 1 E.				North Horn Formation	1020	2204	6898
							Indianola Group	3224	3487	4694
							Unnamed conglomerate	6711	2033	1207
							Cedar Mountain Formation	8744	862	-826
							Twist Gulch Formation	9606	1162	-1688
							Arapien Shale	10768	3668	-2850
							Twin Creek Limestone	14436	309	-6518
							Navajo Sandstone	14745	1088	-6827
							TD	15833		-7915
22	Mobil	Larson Unit 1	SW¼SE¼ sec. 1,	Sanpete	5434	14043	Quaternary Alluvium	0	680	5434

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
			T. 17 S., R. 2 E.				Flagstaff Limestone (estimated top)	680	270	4754
							North Horn Formation	950	810	4484
							Funk Valley Formation	1760	912	3674
							Allen Valley Shale	2672	202	2762
							Sanpete Formation	2874	466	2560
							Unnamed conglomerate	3340	985	2094
							Cedar Mountain Formation	4325	1686	1109
							Twist Gulch Formation	6011	1595	-577
							Arapien Shale	7606	6437	-2172
							TD	14043		-8609
23	Phillips	Price N-1	SE¼SE¼ sec. 29,	Sanpete	5498	12332	Quaternary Alluvium	0	465	5498
			T. 15 S., R. 3 E.				Green River Formation (estimated top)	465	1123	5033
							Colton Formation	1588	392	3910
							Flagstaff Limestone	1980	200	3518
							North Horn Formation	2180	1330	3318
							Funk Valley Formation	3510	925	1988
							Allen Valley Shale	4435	397	1063
							Sanpete Formation	4832	821	666
							Unnamed conglomerate	5653	702	-155
							Cedar Mountain Formation	6355	670	-857
							Twist Gulch Formation	7025	1545	-1527
							Arapien Shale	8570	3762	-3072
							TD	12332		-6834
24	Tennesse Gas	Irons 1	SE¼NE¼ sec. 16,	Sanpete	5527	9995	Quaternary Alluvium	0	465	5527
			T. 15 S., R. 3 E.				Green River Formation (estimated top)	465	1625	5062
							Colton Formation	2090	415	3437
							Flagstaff Limestone	2505	225	3022
							North Horn Formation	2730	2815	2797
							Sixmile Canyon Formation	5545	1005	-18
							Funk Valley Formation	6550	2655	-1023
							Allen Valley Shale	9205	535	-3678
							Sanpete Formation	9740	255	-4213
							TD	9995		-4468
25	Hanson Oil	Moroni 1AX	SE¼NW¼ sec. 14,	Sanpete	5708	21264	Crazy Hollow Formation	0	300	5708
			T. 15 S., R. 3 E.				Green River Formation (estimated top)	300	1355	5408
							Colton Formation	1655	425	4053
							Flagstaff Limestone	2080	220	3628
							North Horn Formation	2300	2780	3408
							Sixmile Canyon Formation	5080	3990	628
							Funk Valley Formation	9070	2480	-3362
							Allen Valley Shale	11550	520	-5842
							Sanpete Formation	12070	302	-6362
							Unnamed conglomerate	12372	733	-6664
							Cedar Mountain Formation	13105	595	-7397
							Twist Gulch Formation	13700	873	-7992

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Arapien Shale	14573	2737	-8865
							Twin Creek Limestone	17310	540	-11602
							Navajo Sandstone	17850	685	-12142
							Petrified Forest Member of Chinle Formation	18535	25	-12827
							Moss Back Member of Chinle Formation	18560	70	-12852
							Upper Red Member of Moenkopi Formation	18630	715	-12922
							Shnabkaib Member of Moenkopi Formation	19345	227	-13637
							Middle Red Member of Moenkopi Formation	19572	257	-13864
							Sinbad Limestone Member of Moenkopi Formation	19829	244	-14121
							Black Dragon Member of Moenkopi Formation	20073	427	-14365
							Black Box Dolomite	20500	340	-14792
							Toroweap Formation	20840	424	-15132
							TD	21264		-15556
26	Phillips	USA-E 1	NW¼NE¼ sec. 27, T. 19 S., R. 3 E.	Sanpete	8031	20450	North Horn Formation	0	1205	8031
							Price River Formation	1205	951	6826
							Castlegate Sandstone	2156	407	5875
							Blackhawk Formation	2563	942	5468
							Star Point Sandstone	3505	654	4526
							Upper Part Blue Gate Member of Mancos Shale	4159	396	3872
							Emery Sandstone Member of Mancos Shale	4555	2135	3476
							Lower Part Blue Gate Member of Mancos Shale	6690	1402	1341
							Ferron Sandstone Member of Mancos Shale	8092	712	-61
							Tununk Member of Mancos Shale	8804	579	-773
							Dakota Sandstone	9383	670	-1352
							Unnamed conglomerate	10053	219	-2022
							Cedar Mountain Formation	10272	690	-2241
							Summerville Formation	10962	555	-2931
							Curtis Formation	11517	172	-3486
							Twist Gulch Formation	11689	504	-3658
							Arapien Shale	12193	968	-4162
							Twin Creek Limestone	13161	570	-5130
							Navajo Sandstone	13731	619	-5700
							Kayenta Formation	14350	270	-6319
							Wingate Sandstone	14620	330	-6589
							Petrified Forest Member of Chinle Formation	14950	300	-6919
							Moss Back Member of Chinle Formation	15250	78	-7219
							Upper Red Member of Moenkopi Formation	15328	614	-7297
							Shnabkaib Member of Moenkopi Formation	15942	85	-7911
							Middle Red Member of Moenkopi Formation	16027	223	-7996
							Sinbad Limestone Member of Moenkopi Formation	16250	238	-8219
							Black Dragon Member of Moenkopi Formation	16488	307	-8457
							Black Box Dolomite	16795	183	-8764
							Toroweap Formation	16978	479	-8947
							Redwall Limestone	17457	755	-9426
							Ouray Limestone	18212	116	-10181

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Elbert Formation	18328	449	-10297
							Lynch Dolomite	18777	639	-10746
							Maxfield Limestone	19416	677	-11385
							Ophir Shale	20093	231	-12062
							Tintic Quartzite	20324	126	-12293
							TD	20450		-12419
27	Surface control I-1631	USGS Miscellaneous Investigations Map I-1631								
28	BWAB	Orangeville Unit 1	NW¼NW¼ sec. 1,	Emery	6119	8560	Blue Gate Member of Mancos Shale	0	2184	6119
			T. 19 S., R. 7 E.				Ferron Sandstone Member of Mancos Shale	2184	306	3935
							Tununk Member of Mancos Shale	2490	586	3629
							Dakota Sandstone	3076	20	3043
							Cedar Mountain Formation	3096	493	3023
							Morrison Formation	3589	418	2530
							Summerville Formation	4007	350	2112
							Curtis Formation	4357	173	1762
							Entrada Sandstone	4530	680	1589
							Carmel Formation (Upper)	5210	590	909
							Carmel Formation (Lower)	5800	259	319
							Navajo Sandstone	6059	487	60
							Kayenta Formation	6546	162	-427
							Wingate Sandstone	6708	344	-589
							Petrified Forest Member of Chinle Formation	7052	98	-933
							Moss Back Member Chinle Formation	7150	80	-1031
							Moody Canyon Member of Moenkopi Formation	7230	409	-1111
							Torrey Member of Moenkopi Formation	7639	341	-1520
							Sinbad Limestone Member of Moenkopi Formation	7980	131	-1861
							Black Dragon Member of Moenkopi Formation	8111	239	-1992
							Black Box Dolomite	8350	134	-2231
							White Rim Sandstone	8484	76	-2365
							TD	8560		-2441
29	Pan American	Ferron Unit 3	SE¼NW¼ sec. 21,	Emery	5948	10022	Blue Gate Member of Mancos Shale	0	798	5948
			T. 20 S., R. 7 E.				Ferron Sandstone Member of Mancos Shale	798	312	5150
							Tununk Member of Mancos Shale	1110	568	4838
							Dakota Sandstone	1678	62	4270
							Cedar Mountain Formation	1740	445	4208
							Morrison Formation	2185	304	3763
							Summerville Formation	2489	406	3459
							Curtis Formation	2895	90	3053
							Entrada Sandstone	2985	800	2963
							Carmel Formation (Upper)	3785	497	2163
							Carmel Formation (Lower)	4282	523	1666
							Navajo Sandstone	4805	610	1143
							Kayenta Formation	5415	210	533
							Wingate Sandstone	5625	267	323

Data point	Operator	Well name	Location	County	KB (ft)	TD (ft)	Formation	Top (ft)	Thickness (ft)	Subsea (ft)
							Petrified Forest Member of Chinle Formation	5892	138	56
							Moss Back Member of Chinle Formation	6030	123	-82
							Moody Canyon Member of Moenkopi Formation	6153	282	-205
							Torrey Member of Moenkopi Formation	6435	376	-487
							Sinbad Limestone Member of Moenkopi Formation	6811	158	-863
							Black Dragon Member of Moenkopi Formation	6969	181	-1021
							Black Box Dolomite	7150	150	-1202
							White Rim Sandstone	7300	443	-1352
							Redwall Limestone	7743	369	-1795
							Ouray Limestone	8112	143	-2164
							Elbert Formation	8255	385	-2307
							Lynch Dolomite	8640	512	-2692
							Maxfield Limestone	9152	568	-3204
							Ophir Shale	9720	211	-3772
							Tintic Quartzite	9931	91	-3983
							TD	10022		-4074
30	Husky Oil	Castledale-Dennison 1	NE¼NW¼ sec. 10, T. 19 S., R. 8 E.	Emery	5608	1088	Blue Gate Member of Mancos Shale	0	125	5608
							Ferron Sandstone Member of Mancos Shale	125	288	5483
							Tununk Member of Mancos Shale	413	513	5195
							Dakota Sandstone	926	149	4682
							Cedar Mountain Formation	1075	13	4533
							TD	1088		4520
31	Hammon	USA Federal 8-1	SE¼NW¼ sec. 8, T. 19 S., R. 9 E.	Emery	5495	6215	Cedar Mountain Formation	0	755	5495
							Morrison Formation	755	445	4740
							Summerville Formation	1200	260	4295
							Curtis Formation	1460	160	4035
							Entrada Sandstone	1620	650	3875
							Carmel Formation (Upper)	2270	168	3225
							Carmel Formation (Lower)	2438	462	3057
							Navajo Sandstone	2900	433	2595
							Kayenta Formation	3333	247	2162
							Wingate Sandstone	3580	270	1915
							Petrified Forest Member of Chinle Formation	3850	105	1645
							Moss Back Member of Chinle Formation	3955	188	1540
							Moody Canyon Member of Moenkopi Formation	4143	289	1352
							Torrey Canyon Member of Moenkopi Formation	4432	254	1063
							Sinbad Limestone Member of Moenkopi Formation	4686	139	809
							Black Dragon Member of Moenkopi Formation	4825	215	670
							Black Box Dolomite	5040	75	455
							White Rim Sandstone	5115	480	380
							Redwall Limestone	5595	305	-100
							Ouray Limestone	5900	67	-405
							Elbert Formation	5967	248	-472
							TD	6215		-720

*U.S. G.P.O.:1994-387-030:36