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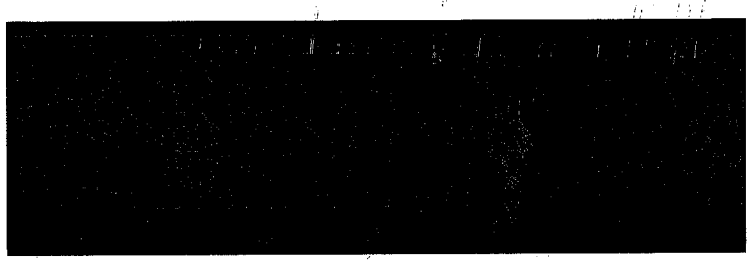

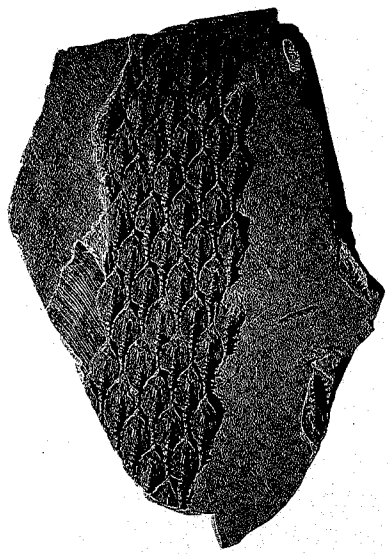

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Cover: *Lepidodendron* sp. from the Manning Canyon Shale Formation. Donated by Gary Harris to the BYU paleobotanical lab.

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Newly Recognized Cedar Mountain Formation in Salina Canyon, Sevier County, Utah

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ABSTRACT

About 1000 ft (300 m) of interbedded conglomerate, sandstone, and variegated bentonitic mudstone are exposed in lower Salina Canyon in Sevier County, Utah. These beds have been identified as Morrison or Morrison(?) Formation since they were first described. This identification was based on their similar lithologic character and stratigraphic position with the Morrison Formation of the San Rafael Swell area. The beds in Salina Canyon overlie the Twist Gulch Formation of middle Jurassic age (equivalent to the Entrada, Curtis, and possibly Summerville Formations) and underlie the Upper Cretaceous Indianola Group. Recently the identity of these beds has been questioned. To resolve this problem, we dated zircons by the external detector fission track method from five bentonitic mudstone samples collected from the central part of the section. These samples yielded dates of 96 ± 5 Ma, 103 ± 8 Ma, 91 ± 4 Ma, 85 ± 5 Ma, and 90 ± 5 Ma. Three of the same samples contained apatites that gave ages of 95 ± 6 Ma, 103 ± 8 Ma, and 105 ± 10 Ma. This suggests an Albian age for this section and a correlation with the Cretaceous Cedar Mountain Formation rather than the Jurassic Morrison Formation. A major disconformity with a hiatus of as much as 60 Ma exists between the Cedar Mountain Formation and the underlying beds in the Salina Canyon area.

INTRODUCTION

A stratigraphic interval of interbedded conglomerate, sandstone, and variegated shale about 1000 ft (300 m) thick is exposed in lower Salina Canyon in Sevier County, Utah (fig. 1). Spieker and Reeside (1926) first examined this section and called it Morrison Formation based upon lithologic appearance and stratigraphic position. The beds overlie the Twist Gulch Formation and underlie the Indianola Group. Later, Spieker (1946, p. 125) recognized "that the same lithologic character [of these beds] is known to be common in the Indianola Group," but unable to find any fossils, he decided to call them Morrison(?) Formation. He also recognized the Twist Gulch as the equivalent of the Jurassic marine and marginal marine units of the San Rafael Swell area (the Entrada, Curtis, and possibly Summerville Formations) and the Indianola Group as Upper Cretaceous.

Though the questioned beds in Salina Canyon are most similar to the Morrison of the San Rafael Swell area, they are gradational with the basal Indianola (Spieker 1949, p. 20). To the north, Stokes (1972) and Standlee (1982) recognized possible Early Cretaceous rocks. Lawton (1985) included the Morrison(?) beds in the Jurassic, but recognized that they may be partly Cretaceous. Witkind and others (1986) obtained Early Cretaceous palynomorphs from rocks in a similar stratigraphic position in the Red Rocks area to the north. He assigned them to the Cedar Mountain Formation on that basis. The age of the beds in Salina Canyon has remained uncertain until the present time with most workers referring to them as Morrison or Morrison(?) (e.g., Williams and Hackman 1971). Weiss and Roche (1987) have recently assigned most of the Morrison(?) beds in central Utah to the Cedar Mountain Formation.

Two separate studies were undertaken by students of Spieker to tie the questioned beds to the strata of the San Rafael Swell area by means of heavy mineral correlations (Bayley 1950, Frazier 1951). They were unsuccessful in this attempt. In 1984, G. C. Willis unsuccessfully attempted to date the beds by palynology (unpublished data). None of the samples collected contained palynomorphs. However, most of the bentonitic horizons do contain zircons and/or apatite that we have been able to date using the external detector method of fission track dating.

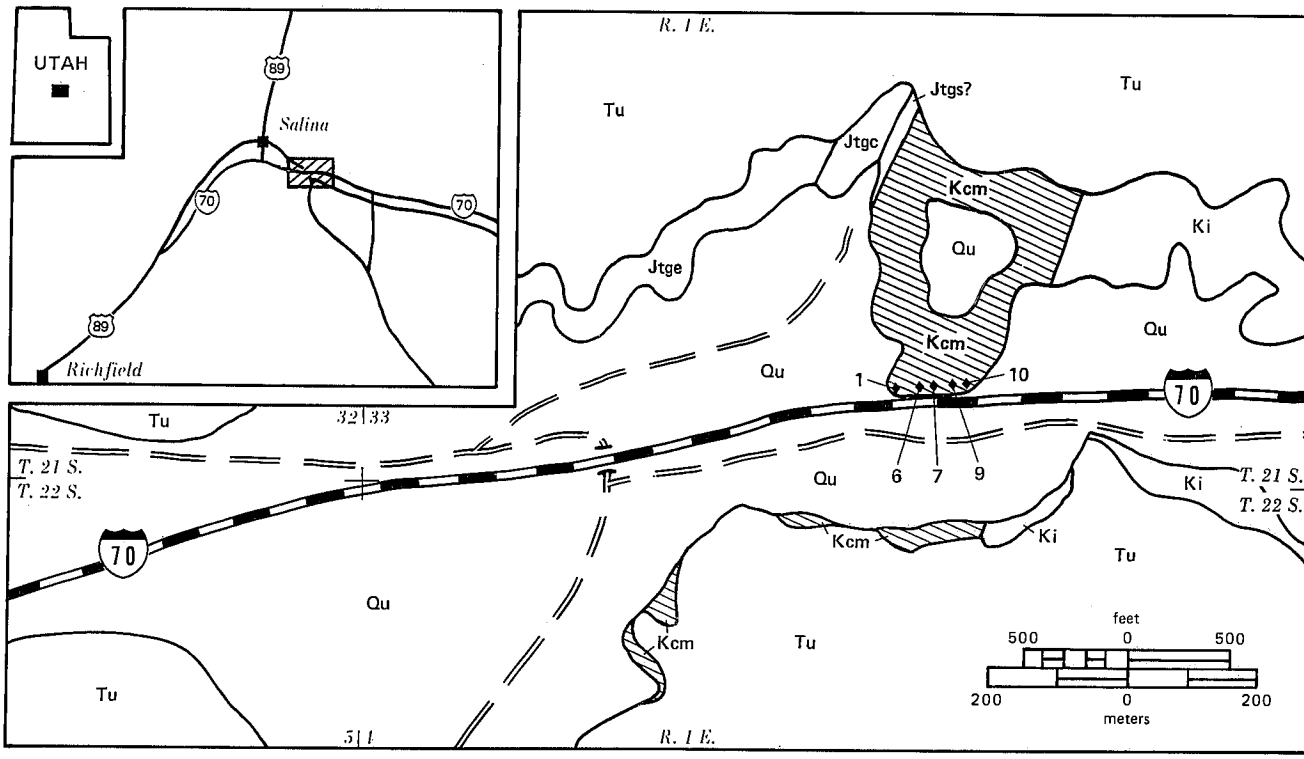

FIGURE 1.—*Index and generalized geologic map showing location of outcrops of the Cedar Mountain Formation (formerly Morrison(?) Formation) in Salina Canyon, Sevier County, Utah (section 33, T. 21 S, R. 1 E). Numbers show collection localities of dated samples: (1) SACM–0101; (6) SACM–0106; (7) SACM–0107; (9) SACM–0109; and (10) SACM–0110.*

SAMPLE COLLECTION AND PREPARATION

A roadcut across part of the outcrop in Salina Canyon has exposed several beds that are quite bentonitic. The exposure has an angular discordance near the middle that we attribute to slumping. However, we do not believe that the strata are out of stratigraphic position. Twelve samples of about 5 lbs. (3 kg) each were collected from the bentonitic mudstone beds, five of which were ultimately dated (fig. 2). These are not primary ash beds, but have been reworked to some extent. The heavy mineral portion of these samples was concentrated by standard panning and heavy liquid techniques that yielded a few hundred grains to an ounce of concentrate containing zircons, apatites, and some other grains. Since the amount of concentrate was generally small, the samples were not run through the magnetic separator for fear of losing some or all of the sample. Instead, the samples were examined under a binocular microscope, and the euhedral grains were handpicked from the sample. Approximately 50–100 grains minimum is needed to obtain an age. Even handpicking of grains may not eliminate all the older detrital grains, but a check of the grain populations using the age spectra approach of Kowallis and others (1986) showed that contamination was minimal in most of the samples after the rounded grains were eliminated.

After the zircons and apatites were separated from the bentonites, they were mounted and prepared using standard methods described by Naeser (1976). The samples were irradiated at the USGS Triga reactor in Denver, Colorado. Each reactor package included two National Bureau of Standards glasses, SRM–963, and a mounted sample of zircon or apatite from the Mount Dromedary Stock in Australia, a sample of known age sent to us by A. J. W. Gleadow that we are testing for use as a Mesozoic age standard. The neutron fluence through the samples was determined by comparing the fission track density in glass SRM–963 with the density in two other samples of the same glass irradiated in the NBS RT–3 and RT–4 sites with a copper foil detector (Carpenter and Reimer 1974). In age calculations, the following constants were used: $\lambda_d = 1.55 \times 10^{-10}$/yr, $\lambda_f = 7.03 \times 10^{-17}$/yr, $U^{235}/U^{238} = 0.00725$. The values used here have been shown to give an accurate age for the Fish Canyon Tuff (Naeser and others 1981), a proposed fission track age standard that has been thoroughly dated by K-Ar methods. Uncertainties in conventional ages were calculated from the uncertainties in fossil and induced counts, along with the uncertainty in counts used to determine neutron fluence, by combining these in the manner described by Green (1981).

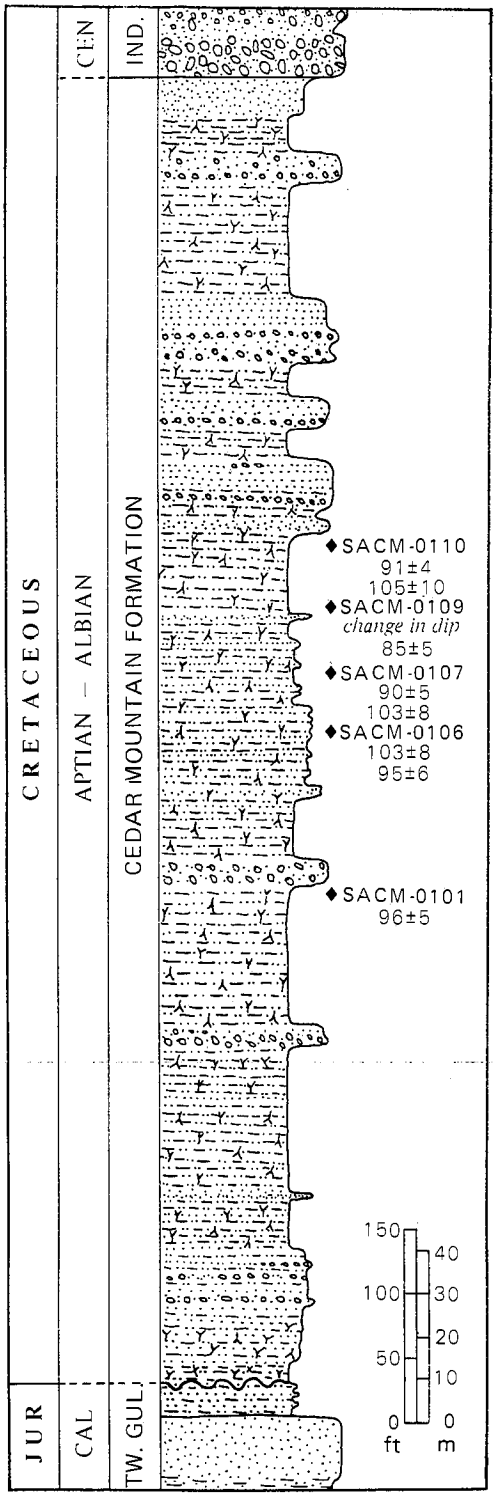

FIGURE 2.—*Stratigraphic section of Cedar Mountain Formation in Salina Canyon showing horizon of each dated sample and ages obtained. Additional samples were collected that did not yield datable material, including two from base of the formation. Outcrop has a sudden change in dip near middle of the exposure that we attribute to slumping. We do not believe there is a significant loss or duplication of the section.*

RESULTS AND DISCUSSION

Table 1 lists the samples and ages obtained from the Salina Canyon section. The zircon ages range from 85–103 Ma, and the apatite ages range from 95–105 Ma. This age range would place these sediments in the Albian-Cenomanian stages according to the Decade of North American Geology time scale (Palmer 1983). The range might suggest that the sediments could be as young as Santonian. However, all of the ages have overlapping errors at two standard deviations so that an overall mean age might better represent the age of the section. The mean age for all of the grains from all of the samples is 92 ± 5 Ma (2 s.d.) for zircons and 96 ± 9 Ma (2 s.d.) for apatite (table 1). Peterson and Ryder (1975) suggested an Aptian to Albian age for the Cedar Mountain Formation. More recently, Tschudy and others (1984) dated the upper Cedar Mountain as latest Albian using palynomorphs. Witkind and others (1986), working further to the north, used palynomorphs to obtain a Jurassic-Cretaceous age for the lower part of the Cedar Mountain Formation as defined by them, and an Aptian-Albian age for the upper part of the section. They further restricted the age of the lower part of their section to the Early Cretaceous by using bivalves collected by Stuecheli (1984). Thus, it appears that no Morrison Formation is present in that area.

Our dates are compatible with a latest Albian age for the Cedar Mountain, but may suggest that it is slightly younger in Salina Canyon than it is to the east in Emery County, Utah, where Tschudy and others (1984) collected their samples. Kowallis and others (1986) and Kowallis and Heaton (1987) have dated Cedar Mountain sediments east of Salina Canyon near Notom, Utah, and obtained ages ranging from 99–108 Ma, again suggesting that the Salina Canyon section may be slightly younger. In any case, the Salina Canyon section is not old enough to be considered as Morrison Formation and thus should be considered part of the Cedar Mountain Formation. Willis (1986) has designated these sediments as Cedar Mountain Formation on a recent geologic map of the Salina Quadrangle.

The grouping of the ages between 85–105 Ma indicates that a major unconformity is located at the base of the section between the Cedar Mountain Formation and the Twist Gulch Formation with a hiatus of about 60 Ma. Some bentonitic beds do exist lower in the section that might further constrain the age of the section and the length of the hiatus, but our samples from these beds yielded only a few very small zircons, most of which fell out of the mounts during processing. Consequently, we have not obtained any ages from these at present. We believe that these lower rocks are Cretaceous as well and unconformably overlie the Twist Gulch Formation even

Table 1. Fission track ages and count data for samples from the Cedar Mountain Formation in Salina Canyon.

Sample Number	Mineral Date	Fossil Track Density tr/cm x 10^6	Fossil Track Density track counts	Induced Track Density tr/cm x 10^6	Induced Track Density track counts	Neutron Fluence n/cm x 10^{15}	Neutron Fluence track counts	No. Grains	Age ± 1SD (Ma)
SACM 0110	Zircon	11.28	1252	9.10	1010	2.46	2150	5	91 ± 4
SACM 0110	Apatite	0.23	239	0.20	206	3.05	2446	10	105 ± 10
SACM 0109	Zircon	11.74	763	10.14	659	2.48	2150	5	85 ± 5
SACM 0107	Zircon	10.53	1169	8.74	970	2.52	2150	5	90 ± 5
SACM 0107	Apatite	0.35	380	0.31	335	3.05	2446	10	103 ± 8
SACM 0106	Zircon	19.35	387	14.15	283	2.54	2150	1	103 ± 8
SACM 0106	Apatite	0.42	548	0.40	521	3.05	2446	10	95 ± 6
SACM 0101	Zircon	8.84	999	7.10	802	2.60	2150	4	96 ± 5
Total	Zircon		4570		3724	2.52	2150	20	92 ± 2
Total	Apatite		1167		1096	3.05	2446	30	96 ± 4

though exposures are poor and the basal contact is not clearly exposed. It appears that the Morrison Formation pinches out beneath the Wasatch Plateau as postulated by Stokes (1972), Standlee (1982), and Witkind and others (1986). However, it is possible, but not likely, that some of the lower beds may be Jurassic Morrison Formation, since in exposures about 50 miles to the southeast Kowallis and Heaton (1987) have shown that the boundary between the Morrison and Cedar Mountain Formations is very obscure, with no obvious break.

The upper beds in this section grade up into the Indianola Group (as noted by Spieker 1946, p. 125). At this locality, the oldest part of the Indianola Group, the Sanpete Formation, is thought to be Albian-Cenomanian (T. F. Lawton personal communication 1985). Our ages would indicate that the basal part of the Sanpete Formation is probably Cenomanian.

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