Upper Cambrian-Lower Ordovician Notch Peak Formation in Western Utah

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Lithostratigraphy, biostratigraphy, and regional correlations of the Notch Peak Formation and descriptions of three new members

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UPPER CAMBRIAN-LOWER ORDOVICIAN NOTCH PEAK FORMATION IN WESTERN UTAH

By LEHI F. HINTZE,[1] MICHAEL E. TAYLOR,[2] and JAMES F. MILLER[3]

ABSTRACT

Three mappable members in the Notch Peak Formation in western Utah are recognized, named, and defined. In ascending order, these are the Hellnmaria, Red Tops, and Lava Dam Members. All members are limestone or dolomite; the Red Tops consists of thin-bedded bioclastic lime grainstone, whereas the other members are more massive, finer textured, and include many high-relief hemispherical stromatolites. The formation ranges from a maximum thickness of 557 meters (m) in the Wah Wah Mountains at the south edge of the area studied to 368 m in the Fish Springs Range at the north edge.

Trilobites representing the *Taenicephalus* and *Idahoia* Zones of the Franconian Stage have been obtained from the Hellnmaria Member. The Red Tops Member contains trilobites of the Trempealeauan *Saukiella junia* Subzone of the *Saukia* Zone; the Lava Dam Member contains faunas of the Trempealeauan *Saukiella serotina* and *Eurekia apopsis* Subzones of the *Saukia* Zone, the Lower Ordovician *Missisquoia depressa* and *Missisquoia typicalis* Subzones of the *Missisquoia* Zone and the *Symphysurina brevispicata* Subzone of the *Symphysurina* Zone.

Two conodont zones and seven subzones have been recognized in the Red Tops and Lava Dam Members of the Notch Peak Formation. The *Proconodontus muelleri* and *Eoconodontus notchpeakensis* Subzones of the *Proconodontus* Zone correspond approximately to the *Saukiella junia* trilobite Subzone in the Red Tops Member. The *Cambrooistodus minutus* Subzone of the *Proconodontus* Zone correlates approximately to the *Saukiella serotina* Subzone in the lower part of the Lava Dam Member. The *Hirsutodontus hirsutus* Subzone of the *Cordylodus proavus* Zone corresponds to the *Eurekia apopsis* Subzone and the overlying *Missisquoia depressa* Subzone. The *Fryxellodontus inornatus* and *Clavohamulus elongatus* Subzones of the *Cordylodus proavus* Zone correspond approximately to the range of the *Missisquoia typicalis* Subzone. The *Hirsutodontus simplex* and *Clavohamulus hintzei* Subzones of the *Cordylodus proavus* Zone correspond to the lower part of the *Symphysurina* Zone in the uppermost part of the Lava Dam Member and the lowermost part of the overlying House Limestone.

INTRODUCTION

The Notch Peak Formation is the uppermost of several Cambrian formations named by Walcott (1908a,b) in the House Range. The intent of Walcott's definition seems clear, but certain aspects of the definition are ambiguous enough to have created problems for later stratigraphers and geologic mappers. First, Walcott did not indicate a stratigraphic top to the formation. Second, Walcott did not identify the location of his measured section precisely enough to enable it to be retraced. Third, the Ordovician age assignment that Walcott made for fossils collected on the summit of Notch Peak is incorrect. Geologic mapping by Hintze (1974a–e) has traced the formation in the House and Confusion Ranges and the Wah Wah Mountains in western Utah (fig. 1) and has delineated three mappable members there. This paper defines these members, describes them in type sections and other reference sections, and documents the biostratigraphic control on their ages.

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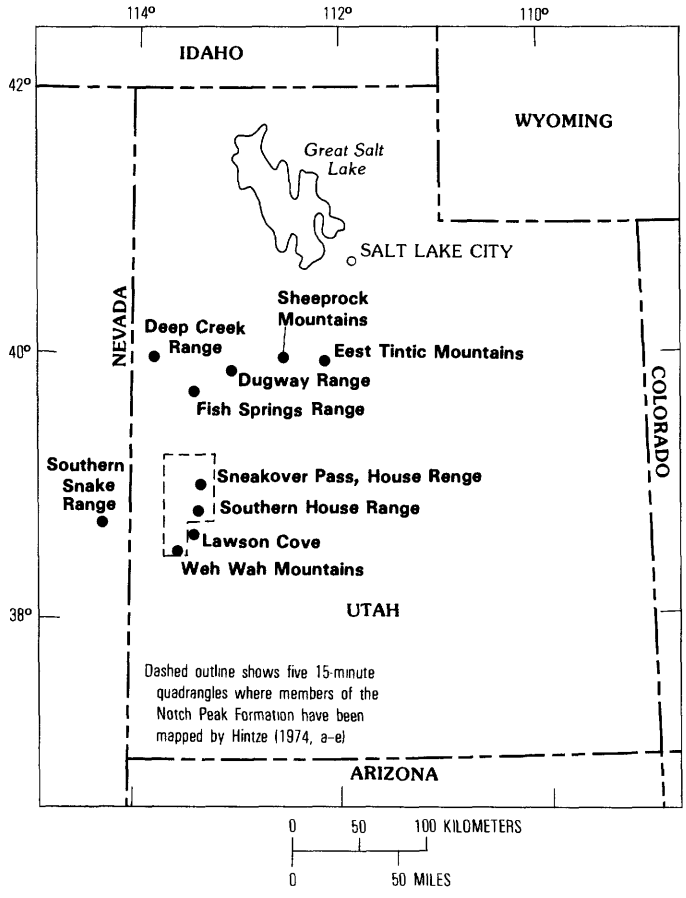

FIGURE 1.—Location of stratigraphic sections discussed in text and shown in figures 2 and 3.

NOTCH PEAK FORMATION BOUNDARIES

The base of the Notch Peak Formation was placed by Walcott (1908a,b) at its contact with the Orr Formation on Orr Ridge. Hintze and Palmer (1976, p. G8) redescribed the Orr Formation at Walcott's type locality in the central House Range and noted that the uppermost member of the Orr, the Sneakover Limestone Member, was included within the Notch Peak Formation on geologic maps by Powell (1959), Hanks (1962), and Whitebread (1969). Geologic maps by Hintze (1974a–e) place the Orr-Notch Peak contact at the horizon originally designated by Walcott. This contact can be readily recognized because the Sneakover Limestone Member is somewhat silty and medium to thick bedded and forms ledges, whereas the massive basal carbonates of the Notch Peak Formation form cliffs. Also the Sneakover Limestone Member contains phosphatic brachiopods and trilobite fragments, whereas the lower Notch Peak carbonates are nearly barren of shelly fossils.

The stratigraphic top of the Notch Peak Formation was not delineated by Walcott (1908a,b) because his measured section ended with the uppermost beds exposed on the summit of Notch Peak. Hintze (1951, p. 12) defined the top of the Notch Peak Formation in the House Range by formally recognizing the Ordovician House Limestone as the stratigraphic unit immediately overlying the "more massive Notch Peak Limestone." Hintze designated a locality on the south flank of Notch Peak (see Hintze, 1973, for locality map) as the type locality for the House Limestone. The geologic contacts shown on the map of the Notch Peak quadrangle (Hintze, 1974a) are in accordance with Hintze's definition of the Notch Peak-House formational contact. It should be noted that Whitebread (1969) did not follow Hintze's (1951) usage of the Notch Peak-House boundary but extended the House Limestone down to include Cambrian beds possibly equivalent to the upper members of the Notch Peak Formation as shown on figure 2.

AGE OF THE NOTCH PEAK FORMATION

Walcott (1908b, p. 173) stated that the summit of Notch Peak "is formed of 285 feet of Ordovician Limestone...containing near the top a distinct fauna:

Obolus (Westonia) notchensis Walcott
Eoorthis coloradoensis (Meek)
Raphistoma sp. etc."

We have recollected from the uppermost beds on the summit and identified the following taxa:

Bayfieldia n. sp.
Bowmania sp.
Euptychaspis sp. indet.
Keithiella(?) sp.
Prosaukia sp. or *Saukiella* sp.
high-spired gastropod, gen. and sp. indet.
echinodermal debris
linguloid brachiopod, gen. and sp. undet.
orthoid brachiopod, gen. and sp. undet.

This fauna can be assigned to either the *Saukiella junia* or *Saukiella serotina* Subzone of the *Saukia* Zone, Trempealeauan Stage. Thus, the beds on the top of the peak are now regarded as Cambrian rather than Ordovician as indicated by Walcott. The geologic map (Hintze, 1974a) shows that the summit of Notch Peak is made up of strata here designated as the Red Tops Member of the Notch Peak Formation. The strata above the Red Tops Member, herein called the Lava Dam Member, were never discussed by Walcott. They are included within the Notch Peak Formation because of Hintze's (1951) defining the top of the Notch Peak Formation as the beds beneath the House Limestone. Hintze (1951) thought that the Cambrian-Ordovician boundary was

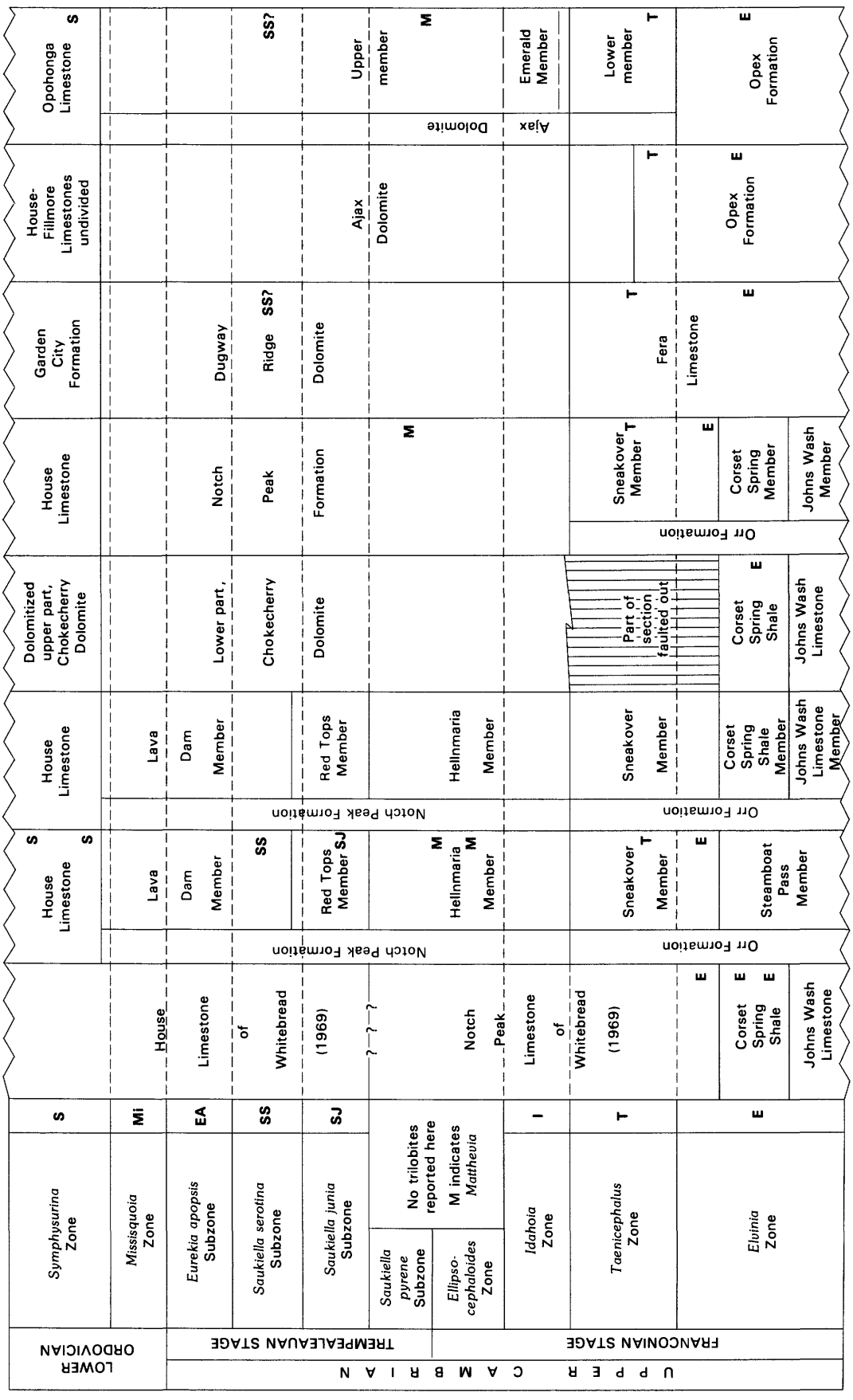

FIGURE 2.—Correlation of the Notch Peak Formation with units in adjacent areas. Fossil collections, where present, are indicated by zone to show basis of correlation.

approximately at his Notch Peak-House formational contact. Subsequent work by Miller (1969) and Taylor (1971) suggested that the upper 30 m of the Lava Dam Member of the Notch Peak Formation as used by Hintze (1951; 1974a–e) includes trilobites of the *Missisquoia* Zone and a conodont assemblage that is generally regarded in North America as lowermost Ordovician (Taylor and Halley, 1974; Landing and others, 1978; Miller, 1978, 1980; Miller and others, 1982). The Hellnmaria Member has yielded a few trilobites that are assigned to the Franconian *Taenicephalus* and *Idahoia* Zones. However, the upper part of the member has not yielded diagnostic fossils so that the position of the boundary between the Franconian and Trempealeauan Stages is unknown.

The Red Tops and Lava Dam Members have yielded an abundance of conodonts and trilobites permitting rather precise zonation of the upper part of the Notch Peak Formation. Thus, as indicated on figure 2 and discussed in greater detail under the section on "Biostratigraphy," the Notch Peak Formation includes fossils ranging from upper Franconian, Trempealeauan, to the Lower Ordovician *Missisquoia* Zone and lowermost *Symphysurina* Zone.

MEMBERS OF THE NOTCH PEAK FORMATION

The Notch Peak Formation is entirely limestone and dolomite and characteristically forms high resistant cliffs that constitute the backbone of several mountain ranges in western Utah. Within the House Range and northern Wah Wah Mountains, the Notch Peak Formation can be divided into three mappable members (Hintze, 1974a–e) based on the occurrence of a bioclastic lime grainstone sequence, the Red Tops Member, near the middle of the formation. This member can be easily traced in the field and on aerial photographs because it is thinly bedded and forms benches, slopes, and low ledges in contrast to the more resistant cliff-forming members above and below. In addition, the Red Tops Member weathers light brown in contrast to the typically drab grays of the other two members of the formation. Where the Red Tops Member is absent, as in the Fish Springs Range (fig. 3), the Notch Peak Formation has not been subdivided.

The principal reference section of the Notch Peak Formation is here established in the House Range in Ts. 19 and 20 S., R. 13 W., Notch Peak, Utah quadrangle, as discussed under "Measured Sections." In addition, three reference sections are described in order to show the variations in lithology and fossil content embraced under the present definition of the Notch Peak Formation.

HELLNMARIA MEMBER (NEW)

The basal member of the Notch Peak Formation derives its name from Hell'n Maria Canyon located in secs. 25, 35, 36, T. 19 S., secs. 3 and 4, T. 20 S., R. 14 W., about 5 km (kilometers) south of Notch Peak in the House Range and shown on the 1960 edition of the Notch Peak 15-minute topographic quadrangle. The geographic name part of the geologic name has been condensed to one word (Hintze, 1973, 1974a–d). The type section is located in the House Range about 10 km southeast of Notch Peak as described in detail under "Measured Sections." The Hellnmaria Member is characteristically a chert-bearing limestone or dolomite that forms massive cliffs and ledges. In its type section in the House Range the member is entirely limestone; in the Fish Springs Range the same interval is almost entirely dolomite (compare columns, fig. 3), and in other areas it is partly limestone and partly dolomite. Whether differences are a result of original depositional facies differences or post-depositional dolomitization is not known.

The Hellnmaria Member has been subdivided on The Barn quadrangle geologic map (Hintze, 1974b) into three map units on the basis of locally traceable variations in lithology, color, and topographic expression; the lower map unit of The Barn subdivisions can be extended southward into the Wah Wah Summit quadrangle (Hintze, 1974e) as well. None of these map units can be recognized to the north in the Notch Peak quadrangle (Hintze, 1974a) or in the Fish Springs Range (Hintze, 1980a,b).

Biostratigraphically significant fossils are rare in the Hellnmaria Member. Miller (1969, p. 415) reported that samples taken from the Steamboat Pass-Lava Dam section of the Hellnmaria Member (Miller's members 2, 3, and 4 are equivalent to the Hellnmaria Member) yielded only rare, undiagnostic conodonts. Trilobites are also rare in the Hellnmaria Member. A fauna assigned to the upper Franconian *Taenicephalus* Zone was collected (USGS locality D2831-CO) 20 m above the base of the Hellnmaria Member in the Steamboat Pass-Lava Dam section. Faunas of approximately the same age occur in the underlying Sneakover Limestone Member of the Orr Formation (Hintze and Palmer, 1976, p. G10). An assemblage (USGS locality 8343-CO) assigned to the upper Franconian *Idahoia* Zone was collected from an unknown horizon in the Hellnmaria Member near U.S. Highway 50, about 7.8 km east of Skull Rock Pass, central House Range.

The polyplacophoran mollusk *Matthevia* (Yochelson, 1966; Runnegar and others, 1979) is common in the middle map unit of the Hellnmaria Member in the southern House Range. There, *Matthevia* is usually coarsely

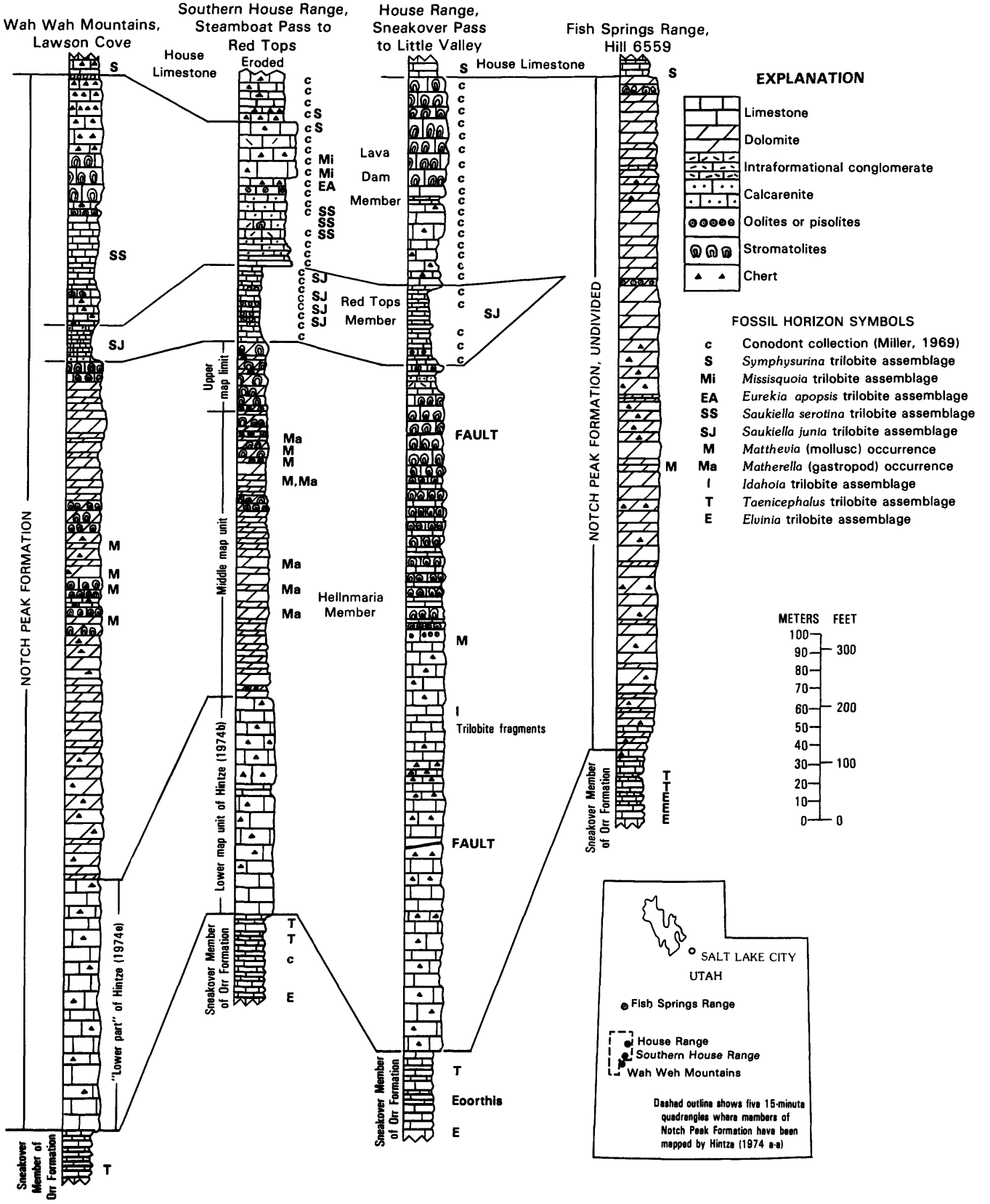

FIGURE 3.—Columnar sections of the Notch Peak Formation described herein under "Measured Sections."

silicified and occurs commonly in association with the gastropod *Matherella*. The occurrences of *Matthevia* are strongly facies-controlled and are usually associated with shoal-water carbonate environments that contain abundant high-relief stromatolites (Yochelson and Taylor, 1974; Runnegar and others, 1979). Where independent biostratigraphic data are available, *Matthevia* is of early Trempealeauan age. Some occurrences lack associated trilobites and could be as old as late Franconian (Runnegar and others, 1979).

Stromatolites were recognized as an important part of the Notch Peak Formation by Hose (1961), who illustrated some examples. Similar stromatolites have been described by Taylor and Cook (1976) from the Whipple Cave Formation of Kellogg (1963) in eastern Nevada and by Campbell (1976) from the Trempealeauan Dotsero Formation in western Colorado. Figure 3 shows that stromatolites are common in the upper half of the Hellnmaria Member in the House Range and Wah Wah Mountains; they are virtually absent in the Fish Springs Range. Stromatolites are useful as indicators of peritidal environments, although they have not been found to be definitive time markers in the Great Basin; no occurrence of them in western Utah has been shown to be laterally extensive enough to serve as a mapping horizon except locally. Stromatolites lend a characteristic appearance to the Hellnmaria Member, for they weather to form massive, smoothly rounded cliffs.

RED TOPS MEMBER (NEW)

The Red Tops Member derives its name from that part of the southern House Range shown as Red Tops in sec. 31, T. 22 S., R. 13 W. on the 1960 edition of The Barn 15-minute topographic quadrangle. The type section is located in the House Range about 8 km southeast of Notch Peak. Description of the type section is given in the section on "Measured Sections." The Steamboat Pass-Lava Dam reference section in the southern House Range has been more closely sampled for trilobites and conodonts than has the type section and is thus important from a biostratigraphic standpoint (Miller and others, 1982). The Red Tops Member consists mostly of thin-bedded bioclastic lime grainstone that forms beds less resistant than the more massive members above and below. Its light brown weathered color also contrasts with the predominantly gray color of the adjacent members. Halite and gypsum occur in some outcrops of the Red Tops Member in the Steamboat Pass-Lava Dam section, southern House Range (Miller, 1978, p. 24). Preliminary petrographic study suggests that the evaporite minerals in the Red Tops are of secondary origin and probably were emplaced by groundwater activity during Tertiary or Quaternary time (Taylor and Glanzman, 1979).

The Red Tops Member is found throughout the House Range. Within the Wah Wah Mountains it thins rapidly to the southwest, diminishing to half its ordinary thickness in the House Range. The Red Tops Member does not occur in the Fish Springs Range. Whether it is represented there by dolomite or whether it has been eroded by pre-House Limestone beveling on the flank of the Tooele Arch (Hintze, 1973a) is not certain.

Conodonts from the Red Tops Member were described by Miller (1969), who identified the Red Tops as member five in his measured sections. The *Proconodontus muelleri*, *Eoconodontus notchpeakensis*, and lower part of the *Cambrooistodus minutus* Subzones of the *Proconodontus* Zone, of middle Trempealeauan age, have been identified in the Red Tops Member (fig. 4 this paper; Miller, 1978). The faunas are discussed more thoroughly in the section on "Biostratigraphy" and by Miller and others (1982).

Trilobite faunas from the Red Tops Member are assigned to the *Saukiella junia* Subzone of the *Saukia* Zone (fig. 4). However, the upper part of the member has yielded few trilobites and may be as young as the *Saukiella serotina* Subzone, an interpretation supported by conodont correlations to areas where faunas of the *S. serotina* Subzone are better represented.

LAVA DAM MEMBER (NEW)

The Lava Dam Member is named for outcrops on both north and south sides of the "Lava Dam," a geologic feature shown by Hintze (1974b) on The Barn 15-minute quadrangle in sec. 6, T. 23 S., R. 13 W. Location and description of the type section near Notch Peak are given in the section on "Measured Sections." The Steamboat Pass-Lava Dam reference section for the Notch Peak Formation in the southern House Range is important to the biostratigraphy because it has yielded abundant conodont and trilobite collections (pl. 1).

The Lava Dam Member is entirely limestone and includes much stromatolitic limestone and cherty limestone in the House Range and Wah Wah Mountains. The member usually forms resistant cliffs and ledges that contrast topographically with the low ledges and rounded slopes of the overlying Pogonip Group.

Conodonts described by Miller (1969) came mostly from the Lava Dam Member, which he informally called member six. Most of the relatively thick *Cambrooistodus minutus* Subzone of the *Proconodontus* Zone is within the lower part of the member. The remainder of the Lava Dam Member is assigned to various subzones

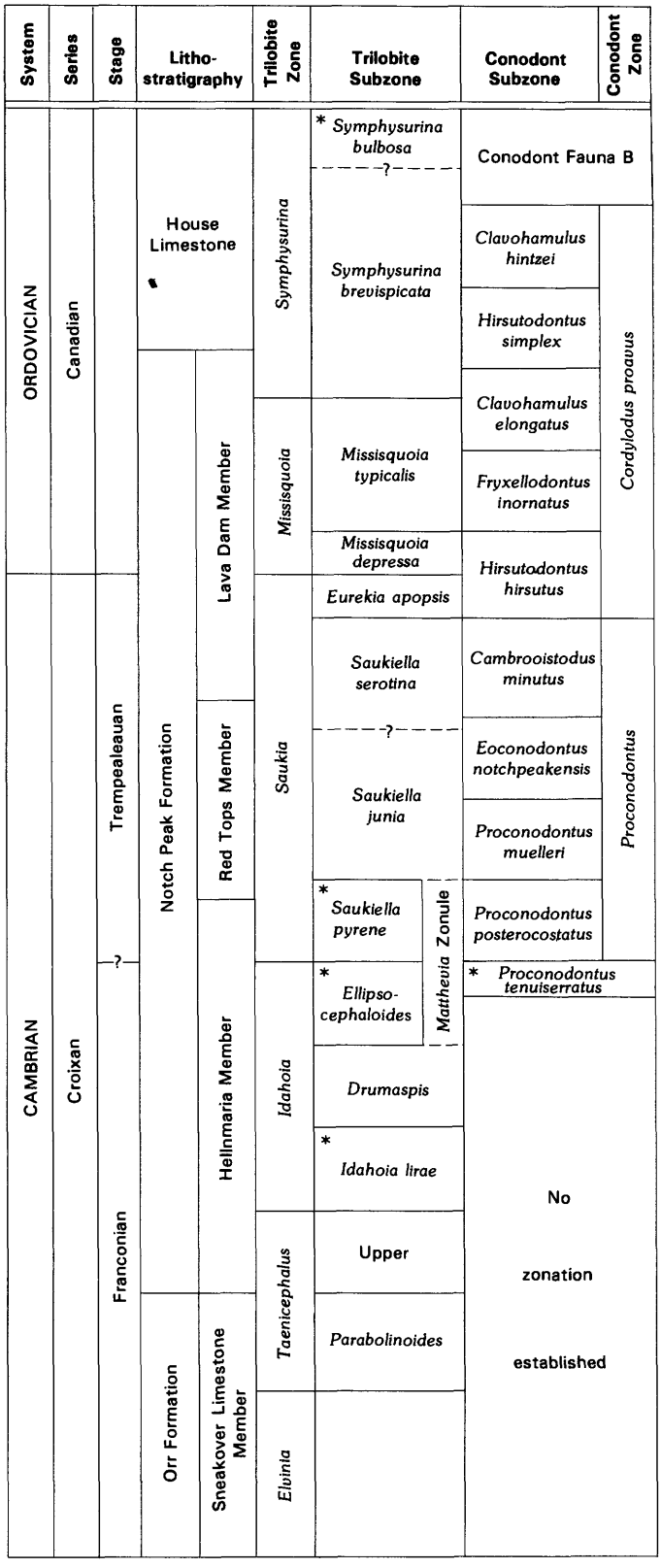

FIGURE 4.—Correlation of conodont and trilobite zones and subzones with the Notch Peak Formation. Trilobite zonal nomenclature from Winston and Nicholls (1967), Longacre (1970), Stitt (1971, 1977), and Miller and others (1982). Asterisk indicates unit not recognized in Notch Peak Formation or adjacent formations but present elsewhere in biostratigraphic position shown.

of the *Cordylodus proavus* Zone (fig. 4), which is equivalent to Fauna A of Ethington and Clark (1971). The uppermost part of the *C. proavus* Zone is in strata assigned to the House Limestone (fig. 4).

Trilobite faunas allow relatively detailed zonation of the Lava Dam Member. The lower 17 m of the Lava Dam Member have not yielded trilobites, but conodont correlations suggest that these beds are equivalent to the *Saukiella serotina* Subzone of the *Saukia* Zone. Trilobite faunas from the Lava Dam Member above 17 m are assigned to the *S. serotina* and *Eurekia apopsis* Subzones of the *Saukia* Zone; the *Missisquoia depressa* and *Missisquoia typicalis* Subzones of the *Missisquoia* Zone; and the lowermost part of the *Symphysurina brevispicata* Subzone of the *Symphysurina* Zone (fig. 4).

Following the present North American practice (Winston and Nicholls, 1967; Taylor and Halley, 1974; Stitt, 1977; Miller and others, 1982), the Cambrian-Ordovician boundary is placed at the base of the *Missisquoia* Zone. This horizon is 43.3 m above the base of the Lava Dam Member in the Steamboat Pass-Lava Dam measured section. This biostratigraphic horizon is recognized by the lowest occurrence of the trilobite *Missisquoia depressa* Stitt, which is within the *Hirsutodontus hirsutus* conodont Subzone in the southern House Range (fig. 4, pl. 1).

Hintze (1982) proposed the term Ibexian to replace Canadian for the Lower Ordovician series in North America. The Cambrian-Ordovician Boundary Working Group, International Union of Geological Sciences, is currently in the process of recommending an international stratotype for the Cambrian-Ordovician boundary. We choose to defer formal acceptance of the Ibexian Series until a decision has been made on the system boundary.

NOTCH PEAK FORMATION CORRELATIVES IN UTAH AND NEVADA

Correlative upper Upper Cambrian and Lower Ordovician carbonate rocks are known by several names in Utah (fig. 2). Although few fossils have been reported from these strata, their correlation with the Notch Peak can be generally established by the widespread occurrence of *Elvinia* Zone trilobites in beds below and *Symphysurina* Zone trilobites in overlying strata (fig. 2).

In the Dugway Range (figs. 1 and 2), Staatz and Carr (1964) described 270 m of mostly dolomites as the Dugway Ridge Dolomite. A thin limestone horizon 33 m

below the top of the Dugway Ridge Dolomite yielded scraps of the trilobite *Eurekia*(?). This thin limestone may correlate with at least part of the Red Tops Member. Species of *Eurekia* are common in the *Saukiella junia* and *Saukiella serotina* Subzones of the *Saukia* Zone.

Cohenour (1959, p. 57) reported that the Ajax Dolomite in the Sheeprock Mountains is 310 m thick and devoid of fossils. Morris and Lovering (1961, p. 48) reported that the combined Emerald Member and upper member of the Ajax Dolomite in the East Tintic Mountains are 116 m thick; the Ajax bears *Eurekia* sp. near its top. More recently, Taylor and Repetski (1985) reported Lower Ordovician conodonts from the upper member of the Ajax in the type section.

The St. Charles Formation in northern Utah consists of three members, the lowest of which is the Worm Creek Quartzite Member. According to Palmer (1971, p. 48) the Worm Creek Quartzite Member is the correlative of the Corset Spring Shale Member of the Orr Formation (fig. 2). The unnamed middle limestone member of the St. Charles Formation bears an abundant "*Ptychaspis* fauna" (Lochman and Hu, 1959) that is here assigned to the *Idahoia* Zone of the Franconian Stage. The upper member of the St. Charles Formation consists of thick to massively bedded dolomite and contains upper *Cordylodus proavus* Zone conodonts at least 14 m below the top (Landing, 1981; Taylor and Landing, 1982). The Garden City Formation disconformably overlies the St. Charles in the Bear River Range and contains upper *Symphysurina* Zone trilobites at its base (Ross, 1951; Taylor and Landing, 1982). Thus, the middle and upper carbonate members of the St. Charles Formation are approximately equivalent to the Notch Peak Formation.

In the Deep Creek Range, Nolan (1935) and Bick (1966) have mapped the Chokecherry Dolomite. Because of faulting, secondary dolomitization, and beveling of the Chokecherry on the flank of the Ordovician Tooele Arch, the upper and lower boundaries of the formation are not clearly defined. The only fossil reported from the part of the Chokecherry that seems most lithologically similar to the Notch Peak Formation is *Scaevogyra*(?), a gastropod of limited value for correlation.

Whitebread (1969) extended the Notch Peak Formation into the southern Snake Range, Nevada, but he selected different mapping boundaries than were used in western Utah. His Notch Peak-House contact was taken at the change from massive cherty limestone, below the contact, to thinner bedded but locally massive limestone above. In the stratigraphic section description that accompanies his map he reported stromatolites from the lower portion of his House Limestone. In Utah sections, the stromatolites would be regarded as indicative of the Notch Peak Formation. Thus, Whitebread's House Limestone appears to include beds that we would include with the upper members of the Notch Peak Formation. Whitebread (1969) did not differentiate an equivalent of the Sneakover Limestone Member of the Orr Formation but extended the Notch Peak downsection to the top of the Corset Spring Shale. However, the basal 210 ft of Notch Peak strata described by Whitebread (1969, p. 5) include pinkish-gray and pale-red silty partings that are typical of the Sneakover Limestone Member of the Orr. The stratigraphic sequence in the southern Snake Range appears to be similar to that in the House Range but the easily mappable lithologic-topographic breaks occur at slightly different positions in the two areas. The Notch Peak Formation has not been used elsewhere in Nevada. In the southern Egan Range of eastern Nevada, Kellogg (1963) mapped coeval Upper Cambrian carbonates as the Whipple Cave Formation. In southeastern Nevada, near Pioche, the name Mendha Formation was applied by Merriam (1964) to a thick sequence of carbonate rocks that bear faunas ranging from the Upper Cambrian *Crepicephalus* and *Elvinia* Zones to the Lower Ordovician *Symphysurina* and *Kainella* Zones. The Mendha Formation occurs in an area of much faulting and its complete sequence has not been described in detail, but it includes strata equivalent to the Notch Peak Formation.

BIOSTRATIGRAPHY

CONODONTS

Conodont samples have been studied from part of the Notch Peak principal reference section (table 1, fig. 5, pl. 1), from the Steamboat Pass-Lava Dam reference section (tables 2, 3; pl. 1), and from several additional sections (not reported here) in the House Range. The systematic relations of these conodonts were described by Miller (1969, 1980), and the biostratigraphy was discussed by Miller (1976, 1978) and Miller and others (1982). The conodont faunal data (tables 1–3) include 24,030 conodonts from 167 samples of limestone and dolomite. The total rock mass processed was 373 kg. Of the two major sections, the Steamboat Pass-Lava Dam reference section by far has the more detailed faunal control.

Conodonts are extremely rare in the Hellnmaria Member of the Notch Peak Formation. In the lower map unit of the Hellnmaria Member in the Steamboat Pass-Lava Dam section, only three conodonts have been found, although the member was sampled extensively. At 17.4 m above the base of the member, two

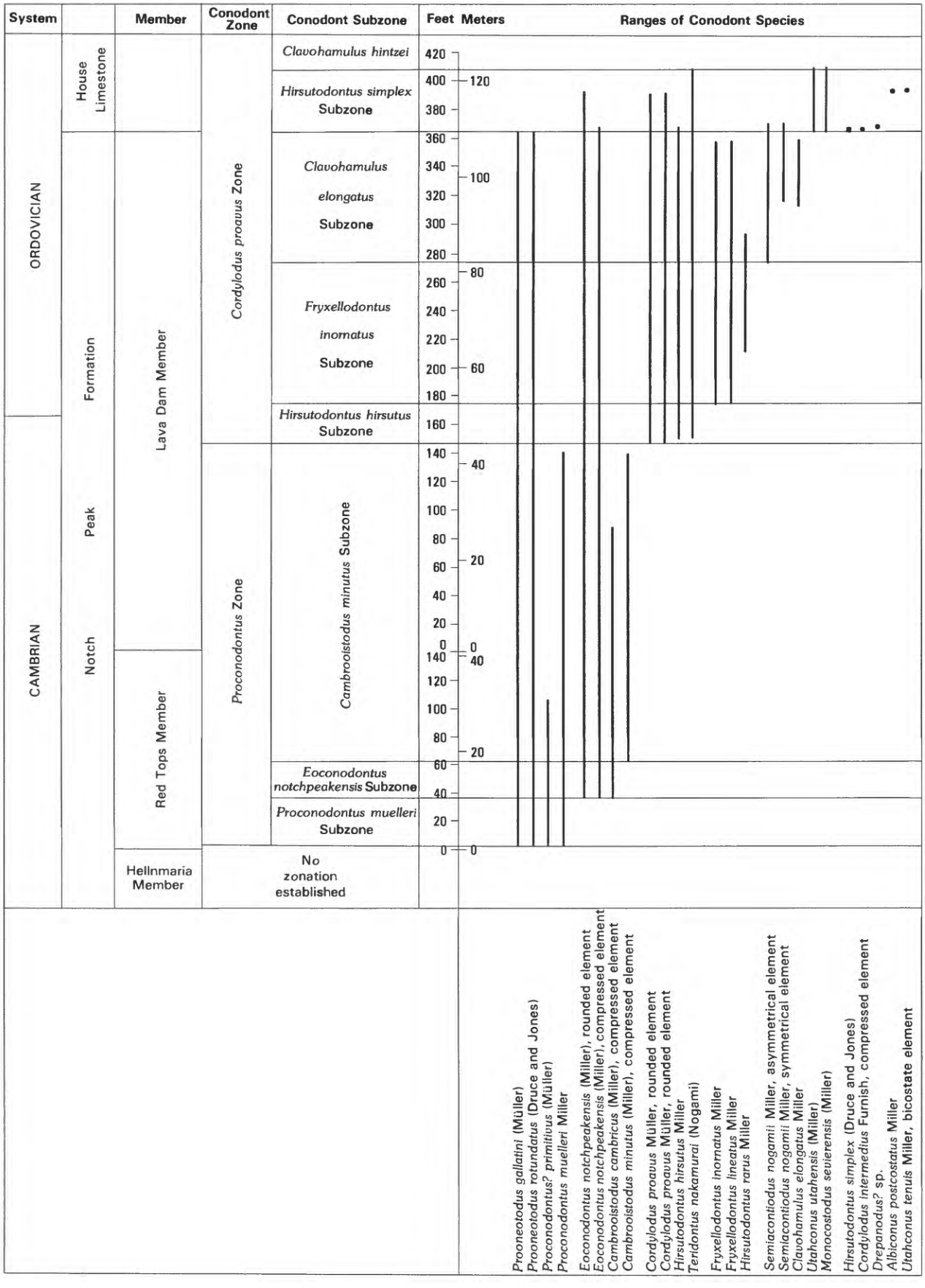

FIGURE 5.—Ranges of conodonts in the principal reference section of the Notch Peak Formation, central House Range, Utah.

TABLE 1.—*Conodont distribution in the principal reference section of the Notch Peak*

[Sample numbers identify stratigraphic unit (RT, Red Tops Member; LD, Lava Dam Member; H, House Limestone), followed by the measured distance in feet above the base of the numbers of specimens per sample are given.

Formation	Notch Peak Formation																										
Member	Rad Tops Member (42.7 m)														Lave Dam Member (110.9 m)												
Sample mass (kilograms) processed	2.7	2.0	3.3	3.2	3.1	2.8	3.1	4.7	6.1	3.0	3.4	2.9	2.9	1.0	0.9	0.9	0.9	0.9	0.9	0.9	1.0	0.9	1.0	2.1			
Meters above base of member	0.9	3.0	9.8	11.0	13.7	18.6	21.6	25.3	27.4	32.9	35.1	40.8	42.7	0.0	3.4	6.1	10.1	12.8	15.5	19.8	22.3	26.8	30.2	33.5			
Sample number	RT-3	RT-10	RT-32	RT-36	RT-45	RT-61	RT-71	RT-83	RT-90	RT-108	RT-115	RT-134	RT-140	LD-0	LD-11	LD-20	LD-33	LD-42	LD-51	LD-65	LD-73	LD-88	LD-99	LD-110			
Conodonts:																											
Prooneotodus gallatini (Müller)	7	---	---	5	6	---	10	7	17	1	1	---	2	1	---	---	---	---	---	---	---	---	---	---			
Prooneotodus rotundatus (Druce and Jones)	5	---	---	4	---	---	2	2	7	---	---	---	6	---	---	---	---	---	---	---	---	1	---	---			
Proconodontus? primitivus (Müller)	1	---	---	---	---	---	2	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Proconodontus muelleri Miller	29	3	---	27	46	5	11	11	74	10	8	2	32	1	---	---	---	---	---	---	---	1	1	4			
Eoconodontus notchpeakensis (Miller), rounded element	---	---	---	26	15	12	52	1	52	1	5	---	21	2	---	2	---	---	2	1	2	2	3	2			
Eoconodontus notchpeakensis (Miller), compressed element	---	---	---	10	12	1	20	1	13	1	2	---	3	---	---	---	1	---	---	---	---	---	---	---			
Cambrooistodus cambricus (Miller), compressed element	---	---	---	1	3	---	2	---	---	---	---	---	---	---	---	---	---	---	---	1	---	1	---	---			
Cambrooistodus minutus (Miller), compressed element	---	---	---	---	---	1	---	---	3	1	---	---	3	---	---	1	2	---	---	1	---	---	---	1			
Cordylodus proavus Müller, rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Cordylodus proavus Müller, compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Hirsutodontus hirsutus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Teridontus nakamurai (Nogami)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Fryxellodontus inornatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Fryxellodontus lineatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Hirsutodontus rarus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Semiacontiodus nogamii Miller, asymmetrical element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Semiacontiodus nogamii Miller, symmetrical element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Clavohamulus elongatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Utahconus utahensis (Miller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Monocostodus sevierensis (Miller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Hirsutodontus simplex (Druce and Jones)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Cordylodus intermedius Furnish, compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Drepanodus? sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Albiconus postcostatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Utahconus tenuis Miller, bicostate element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---			
Total specimens per sample	42	3	---	73	82	19	99	22	166	15	16	2	67	4	---	3	3	---	2	3	2	5	4	7			

Prooneotodus gallatini (Müller) were found, and at 28 m above the base, a single *Westergaardodina bicuspidata* Müller was found. These species are not diagnostic of age, but are consistent with the presence of *Taenicephalus* Zone trilobites in this part of the Hellnmaria Member. The type section of the Hellnmaria Member has not been sampled for conodonts. However, a systematic search in the member 6.5 km to the west (NP section of Miller, 1969) produced no conodonts. A few long-ranging species of conodonts were found in an isolated sample (USGS loc. 8343-CO) from the Hellnmaria Member approximately 5 km south of the type section. A list of taxa found at that locality is given in the section on "Trilobites."

Additional conodont faunas, possibly from the Hellnmaria Member, are known from the Chalk Knolls area, between the House and Confusion Ranges. The stratigraphic relations there are unclear because of facies changes between limestones of the Notch Peak principal reference section and dolomites of the sections to the

Formation and lower part of the House Limestone, central House Range, Utah

member. Renumbering begins at base of Lava Dam Member and continues into the House Limestone. Numbers of identified specimens of each species in each sample, and total
A range chart is given in figure 5.]

Notch Peak Formation																												House Limestone		
Leve Dam Member (110.9 m)																														
2.2	1.2	2.6	0.7	4.9	2.4	1.9	2.9	3.3	1.9	3.2	5.5	1.5	1.1	2.3	1.0	1.8	2.6	1.4	6.0	2.4	4.0	2.7	3.1	2.1	0.9	0.6	2.8	2.6	2.1	2.6
35.7	40.5	42.7	43.7	44.5	45.4	46.3	46.6	48.5	49.1	50.6	51.8	53.0	54.9	57.0	59.1	64.6	72.2	76.2	82.9	89.0	94.2	94.5	101.2	104.9	108.8	110.6	110.9	112.2	119.5	124.1
LD-117	LD-133	LD-140	LD-143.5	LD-146	LD-149	LD-152	LD-153	LD-159	LD-161	LD-166	LD-170	LD-174	LD-180	LD-187	LD-194	LD-212	LD-237	LD-250	LD-272	LD-292	LD-309	LD-310	LD-332	LD-344	LD-357	LD-363	LD-364	H-368	H-392	H-407
---	---	3	---	5	---	---	4	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	23	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	4	65	5	6	6	10	23	1	2	9	21	464	2	30	7	14	3	2	15	4	24	31	11	9	45	1	31	8	1	---
---	---	32	2	---	2	2	12	1	---	2	14	158	2	8	5	12	4	2	7	3	20	23	4	6	24	---	2	1	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	7	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	6	36	8	---	56	---	---	6	43	473	---	105	---	21	17	6	27	7	43	52	8	8	42	41	121	22	18	---
---	---	---	2	10	---	---	8	---	---	2	10	46	---	30	---	4	9	1	5	5	13	28	3	---	5	7	34	2	9	---
---	---	---	---	---	2	---	2	---	2	3	---	13	---	---	---	---	---	---	---	---	---	---	---	---	---	50	42	10	---	---
---	---	---	---	---	3	---	3	---	---	3	2	192	---	30	1	7	3	5	11	5	12	37	12	101	110	103	130	22	3	1
---	---	---	---	---	---	---	---	---	---	---	---	17	---	14	2	1	1	---	47	---	---	2	1	4	3	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	1	---	3	---	---	---	---	5	---	---	1	1	---	2	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	3	---	1	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	1	1	---	1	45	69	4	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	5	5	1	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	11	25	186	162	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	60	81	27	4	1
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	30	387	9	3	2
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	24	7	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1
---	4	130	15	58	21	12	108	2	4	25	90	1364	4	220	15	60	37	19	118	25	112	186	66	316	394	369	913	106	40	5

south and north (fig. 3). *Proconodontus tenuiserratus* Miller and *P. posterocostatus* Miller occur together beneath faunas assigned to the *P. muelleri* Subzone of the *Proconodontus* Zone. These occurrences are in the same homotaxial position as strata assigned to the *Proconodontus posterocostatus* Subzone of the *Proconodontus* Zone in the Wilberns Formation of Texas and in the Fort Sill Limestone of Oklahoma (Miller and others, 1982). Trilobites found with this association of conodont species in Texas and Oklahoma are of earliest Trempealeauan age. Therefore, strata of this age are present in the Notch Peak Formation in the study area, although the member to which these strata should be assigned is unclear. These data suggest that the Hellnmaria Member (or its equivalents) may represent continuous deposition without major hiatus.

Conodonts are present throughout the Red Tops and Lava Dam Members of the Notch Peak Formation (tables 1–3). The conodont biostratigraphy of these strata was discussed by Miller (1978), Miller in Taylor

TABLE 2.—*Conodont distribution in the Notch Peak Formation in the Steamboat Pass*

[Sample numbers identify lithostratigraphic unit (RT, Red Tops Member; LD, Lava Dam Member), followed by the measured distance in feet above the base of the member. Numbers

Formation	Notch Peak Formation																	
Member	Red Tops Member (40 m)																	
Sample mass (kilograms) processed	0.8	0.6	0.6	0.8	0.8	0.7	0.6	0.6	0.6	0.6	3.2	3.0	0.6	0.6	0.8	0.6	0.7
Meters above base of member	0	1.5	3.0	4.6	6.1	7.6	9.1	10.7	12.5	13.7	15.8	18.9	19.8	21.3	22.9	25.9	28.3
Sample number	RT-0	RT-5	RT-10	RT-15	RT-20	RT-25	RT-30	RT-35	RT-41	RT-45	RT-52	RT-62	RT-65	RT-70	RT-75	RT-85	RT-93
Conodonts:																	
Proconodontus muelleri Miller	---	1	---	7	6	3	---	2	---	---	2	---	---	6	1	---	---
Eoconodontus notchpeakensis (Miller), rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	4	1	1	1
Eoconodontus notchpeakensis (Miller), compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---
Prooneotodus gallatini (Müller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Prooneotodus rotundatus (Druce and Jones)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Proconodontus? primitivus (Müller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cambrooistodus cambricus (Miller), compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cambrooistodus minutus (Miller), compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cordylodus proavus Müller, rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Cordylodus proavus Müller, compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hirsutodontus hirsutus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Hirsutodontus rarus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Teridontus nakamurai (Nogami)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Fryxellodontus inornatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Total specimens per sample	---	1	---	7	6	3	---	2	---	---	2	---	---	11	2	1	1

and Miller (1981), and Miller and others (1982). The Red Tops and lower part of the Lava Dam Members are assigned to the *Proconodontus* Zone. The upper part of the Lava Dam Member and the lower part of the overlying House Limestone are assigned to the *Cordylodus proavus* Zone (fig. 4). Conodonts of the *Proconodontus* Zone are modest in abundance and diversity compared with those of the *C. proavus* Zone. Tables 1 and 2 show that occasional barren samples, though usually of small size, were found in the lower zone, whereas all samples in the upper zone were productive, and some samples yielded abundant faunas.

The *Proconodontus* Zone is divided into four subzones (Miller and others, 1982), although the lowermost subzone is not recognized in any of the sections discussed in this report. The base of the *Proconodontus muelleri* Subzone nearly corresponds with the base of the Red Tops Member, which represents a major environmental and lithologic change from the Hellnmaria Member below (fig. 3, pl. 1). The lower part of the Red Tops Member in the type section and in the Steamboat Pass-Lava Dam section is assigned to the *P. muelleri* Subzone. The middle to upper part of the Red Tops Member is assigned to the *Eoconodontus notchpeakensis* Subzone. The uppermost beds of the Red Tops Member and about the lower half of the Lava Dam Member are assigned to the *Cambrooistodus minutus* Subzone, the uppermost subzone of the *Proconodontus* Zone.

The *Cordylodus proavus* Zone is divided into five subzones, four of which are represented in the Lava Dam Member; the uppermost subzone is found in the lower part of the House Limestone. The *Hirsutodontus hirsutus* Subzone is the lowest and thinnest subzone and is present near the middle of the Lava Dam Member. As discussed below, the Cambrian-Ordovician boundary falls within this subzone (pl. 1). The overlying *Fryxellodontus inornatus* and *Clavohamulus elongatus* Subzones are recognized in both sections studied and occur in the upper part of the Lava Dam Member. The uppermost beds of the Lava Dam Member are assigned to the lower part of the *Hirsutodontus simplex* Subzone; most of this subzone is represented in the lower part of the House Limestone. The highest strata of the Steamboat Pass-Lava Dam section are assigned to the House Limestone, although Miller (1969) earlier assigned these beds to member six of the Notch Peak Formation in his LDS (Lava Dam South) measured section, located a few hundred meters south of the Lava Dam segment of the Steamboat Pass-Lava Dam section reported here. The uppermost beds of the Steamboat Pass-Lava Dam section contain the diagnostic fauna of the *Clavohamulus hintzei* Subzone. *Utahconus tenuis*

segment of the Steamboat Pass-Lava Dam section, southern House Range, Utah

of identified specimens of each species by sample and total number of specimens per sample are shown. A composite range chart of data from tables 2, 3, and 4 is given in plate 1]

Notch Peak Formation																																							
Red Tops Member (40 m)										Lava Dam Member (82.6 m)																															
0.8	0.8	1.7	3.5	0.8	0.8	0.8	2.5	2.5		0.7	0.8	0.8	0.6	0.7	0.7	0.7	1.0	0.8	0.8	0.9	0.7	1.0	0.7	0.9	0.9	3.7	4.5	2.5	3.3	3.0	2.3									
29.0	29.6	30.5	32.0	32.6	34.4	35.1	36.6	37.5		0.9	2.7	4.3	5.5	7.3	8.5	11.6	16.2	18.0	19.8	21.3	22.6	24.4	25.9	27.4	29.0	43.3	46.9	48.8	49.4	51.8	53.6									
RT-95	RT-97	RT-100	RT-105	RT-107	RT-113	RT-115	RT-120	RT-123		LD-3	LD-9	LD-14	LD-18	LD-24	LD-28	LD-38	LD-53	LD-59	LD-65	LD-70	LD-74	LD-80	LD-85	LD-90	LD-95	LD-142	LD-154	LD-160	LD-162	LD-170	LD-176									
1	---	5	38	25	---	2	3	3		---	2	---	---	---	---	---	---	---	4	1	---	---	3	4	1	2	---	---	---	---	---									
---	1	5	37	15	1	1	6	2		---	---	---	---	---	---	---	7	3	2	4	10	2	2	3	6	19	10	4	35	235	7									
---	---	---	12	3	---	---	---	---		---	---	---	---	---	---	---	4	---	---	1	4	---	---	---	1	7	3	---	5	62	3									
---	---	5	13	14	---	---	1	---		---	1	---	---	---	---	---	1	---	1	---	4	---	---	---	---	---	1	---	---	---	---									
---	---	---	20	9	---	---	---	1		---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---									
---	---	---	---	2	---	---	---	---		---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---									
---	---	---	---	1	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---									
---	---	---	---	---	---	---	1	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	---	---	---	---	---									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	10	1	2	531	38									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3	1	2	52	15									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	2	18	---	---									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3	---	---									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3	1									
---	---	---	---	---	---	---	---	---		---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	81	1									
1	1	15	120	69	1	3	11	6		---	3	---	---	---	---	---	12	3	8	6	19	2	5	7	8	30	27	8	65	964	65									

Miller was found in the highest sample collected from the lower beds of the House Limestone at the principal reference section of the Notch Peak Formation (pl. 1). Because this species is known only from the middle and upper part of the *Clavohamulus hintzei* Subzone in Utah, Texas, and Oklahoma (Miller and others, 1982), the base of the *C. hintzei* Subzone probably is somewhat below the horizon from which this highest sample was collected.

The top of the *Cordylodus proavus* Zone has not been recognized in either of the two sections reported here. Samples collected 1.6 km north of the Steamboat Pass-Lava Dam section [LDN (Lava Dam North) section of Miller, 1969] indicate that only the top few feet of the *C. proavus* Zone are missing from the Steamboat Pass-Lava Dam section. The overlying strata at the LDN section contain conodont Fauna B of Ethington and Clark (1971) (Miller, 1978; Miller and others, 1982).

Upon comparing conodont biostratigraphic units between the principal reference section and the Steamboat Pass-Lava Dam section (fig. 6), several important conclusions are evident. In the Red Tops Member, the relative position of both the *Proconodontus muelleri-Eoconodontus notchpeakensis* Subzone boundary and the *Eoconodontus notchpeakensis-Cambrooistodus minutus* Subzone boundary are stratigraphically higher in the Steamboat Pass-Lava Dam section than in the principal reference section. This relationship suggests that the base of the Red Tops Member may be younger in the principal reference section than in the Steamboat Pass-Lava Dam section. Using similar reasoning regarding the relative proximity of the Red Tops-Lava Dam contact to the base of the *Cambrooistodus minutus* Subzone, it can be inferred that this stratigraphic contact may also be younger in the principal reference section than in the Steamboat Pass-Lava Dam Section.

The *Proconodontus muelleri* and *Eoconodontus notchpeakensis* Subzones are thicker in the Steamboat Pass-Lava Dam section compared with the principal reference section. This relationship is reversed for most of the younger biostratigraphic units in these sections (compare columns on fig. 6), and the *Cambrooistodus minutus* through *Clavohamulus elongatus* Subzones are all thicker in the principal reference section. The greater thickness of the *Fryxellodontus inornatus* and *Clavohamulus elongatus* Subzones in the principal reference section may be related to relatively rapid accumulation of the algal stromatolite sediment in the upper part of the Lava Dam Member (compare columns 2 and 3 on fig. 3). The base of the *Hirsutodontus simplex* Subzone is only slightly below the Notch Peak Formation-House Limestone contact in both sections.

TABLE 3.—*Conodont distribution in the Notch Peak Formation and lower House Limestone in*

[Sample numbers identify lithostratigraphic unit (RT, Red Tops Member; LD, Lava Dam Member; H, House Limestone), followed by the measured distance in feet above the base and total number of specimens per sample are shown. A composite

Formation	Notch Peak Formation																														
Mamber	Red Tops Mamber (20.1 m)																				Lava Dam Mamber (77.4 m)										
Meters abova base of mamber	0.2	0.3	1.5	1.8	3.0	3.7	4.6	5.8	7.9	8.2	9.1	10.1	10.4	11.9	12.5	14.3	16.8	18.6	20.1	0.6	1.8	3.0	4.6	6.1	11.0	16.8	22.6	27.1	32.3		
Sampla mass (kilograms) procassed	3.1	4.5	1.6	3.2	3.2	4.6	2.8	2.3	2.7	2.8	2.9	3.1	2.8	3.4	2.9	3.2	3.0	2.8	3.4	2.9	3.4	3.2	3.6	3.0	3.3	3.2	3.5	3.5	3.4		
Sampla number	RT-0.5	RT-1	RT-5	RT-6	RT-10	RT-12	RT-15	RT-19	RT-26	RT-27	RT-30	RT-33	RT-34	RT-39	RT-41	RT-47	RT-55	RT-61	RT-66	LD-2	LD-6	LD-10	LD-15	LD-20	LD-36	LD-55	LD-74	LD-89	LD-106		
Conodonts:																															
Proconodontus muelleri Miller	42	28	15	4	4	58	3	2	4	25	21	4	27	58	---	23	14	18	26	9	11	15	---	8	6	5	28	17	5		
Eoconodontus notchpeakensis (Miller), rounded element	40	35	20	47	4	39	3	---	5	59	40	38	95	115	4	41	10	18	33	5	---	35	11	15	4	13	25	21	18		
Eoconodontus notchpeakensis (Miller), compressed element	17	13	3	13	3	7	4	---	---	10	13	6	26	12	2	18	6	3	17	1	4	12	9	6	1	8	16	4	9		
Prooneotodus gallatini (Müller)	22	17	2	1	4	9	---	---	---	14	2	2	---	37	---	17	---	5	3	1	2	9	---	3	---	---	---	6	---		
Prooneotodus rotundatus (Druce and Jones)	23	14	4	3	1	1	---	---	---	2	---	---	2	16	---	16	---	6	3	---	---	1	---	---	---	---	---	---	---		
Phakelodus tenuis (Müller)	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Proconodontus? primitivus (Müller)	4	2	---	---	1	---	---	---	---	---	---	---	---	4	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---		
Prosagittodontus eureka (Müller)	1	3	---	---	---	1	---	---	---	3	---	---	---	---	---	---	---	---	3	---	---	---	---	---	---	---	---	---	---		
Cambrooistodus cambricus (Miller), compressed element	---	1	2	---	---	---	---	---	---	---	1	---	---	---	---	1	1	---	2	---	---	---	---	---	---	1	---	2	---		
Problematoconites perforata Müller	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Cambrooistodus minutus (Miller), compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	3	---	---	---	---	7	---	3	2	2	---	2	---	2		
Proconodontus serratus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	---	---	---	3	---	---	---	---	---	---	---		
Cordylodus proavus Müller, rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Cordylodus proavus Müller, compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Hirsutodontus hirsutus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Hirsutodontus rarus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Teridontus nakamurai (Nogami)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Fryxellodontus inornatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Fryxellodontus lineatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Clavohamulus elongatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Clavohamulus bulbosa (Miller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Semiacontiodus nogamii Miller, asymmetrical element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Semiacontiodus nogamii Miller, symmetrical element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Utahconus utahensis (Miller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Monocostodus sevierensis (Miller)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Hirsutodontus simplex (Druce and Jones)	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Albiconus postcostatus Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Furnishina? sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Semiacontiodus lavadamensis (Miller), symmetrical element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Cordylodus intermedius Furnish, rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Cordylodus intermedius Furnish, compressed element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Clavohamulus hintzei Miller	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Utahconus tenuis Miller, bicostate element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Paltodus sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Cordylodus drucei Miller, rounded element	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---		
Total specimens per sample	150	113	46	68	17	115	10	2	9	113	77	51	150	242	6	119	32	50	87	16	24	75	23	35	13	27	71	50	34		

the Lava Dam segment of the Steamboat Pass-Lava Dam section, southern House Range, Utah

of the unit. Renumbering begins at the base of the Lava Dam Member and continues into the House Limestone. Numbers of identified specimens of each species by sample range chart of data from tables 2, 3, and 4 is given in plate 1]

Notch Peak Formation																						House Limestone												
Lava Dam Member (77.4 m)																																		
36.6	39.6	40.5	43.0	43.3	43.6	44.3	44.8	45.4	45.7	46.3	47.5	50.3	57.9	65.2	67.1	68.3	70.1	71.6	72.8	74.4	76.2	77.7	79.2	84.1	90.2	91.7	93.0	94.5	96.0	97.5	99.1	100.6	101.5	104.5
3.3	4.5	12.2	3.5	2.0	3.1	2.8	3.5	3.4	2.8	6.3	3.8	2.9	3.1	1.4	1.4	0.7	1.6	0.6	0.2	0.3	0.5	0.5	0.2	0.5	3.6	1.8	1.9	1.9	2.0	4.4	1.7	1.9	3.2	0.7
LD-120	LD-130	LD-133	LD-141	LD-142	LD-143	LD-145.5	LD-147	LD-149	LD-150	LD-152	LD-156	LD-165	LD-190	LD-214	LD-220	LD-224	LD-230	LD-235	LD-239	LD-244	LD-250	H-255	H-260	H-276	H-296	H-301	H-305	H-310	H-315	H-320	H-325	H-330	H-333	H-343
---	83	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
3	739	26	3	242	23	23	10	309	27	33	46	139	380	255	165	81	73	128	62	75	71	7	7	15	47	33	5	6	21	30	4	13	30	7
3	196	14	4	54	16	8	2	94	7	26	16	65	165	123	76	45	23	63	24	15	15	1	7	5	32	19	7	6	6	2	---	2	14	---
---	52	---	---	1	---	---	1	---	---	1	1	---	---	---	---	---	---	---	---	---	1	---	5	2	5	2	---	---	---	1	---	---	---	---
1	18	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4	---	---	---	1	1	3	1	1	---	---	---	---	---	---	---	1
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---	2	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
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---	71	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
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---	---	98	5	255	26	50	26	230	59	120	204	244	213	441	156	141	81	150	103	10	14	31	48	25	103	102	22	45	68	44	21	30	81	17
---	---	21	1	27	9	9	10	21	11	52	71	60	48	128	45	40	9	29	20	1	8	10	8	6	14	17	6	22	21	20	5	7	19	6
---	---	---	2	---	---	---	1	---	---	---	2	1	---	---	---	---	---	---	---	1	13	20	---	8	4	8	---	---	2	6	---	1	2	2
---	---	---	---	202	---	---	---	---	---	---	---	6	13	---	---	2	---	2	---	---	---	---	---	1	---	7	1	3	2	146	---	---	---	4
---	---	---	---	29	6	1	1	33	1	7	9	58	190	57	45	43	35	97	170	476	185	71	157	101	340	246	52	174	127	---	26	51	340	58
---	---	---	---	---	---	?1	2	15	2	2	5	5	6	6	3	10	5	13	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	3	---	1	---	2	---	1	1	4	5	2	2	1	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6	18	15	104	24	123	---	---	---	---	---	---	---	---	---	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5	3	11	52	27	---	---	2	---	1	1	---	1	1	---	---	---	---
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5	10	41	3	27	2	34	8	5	24	8	17	36	17	4	4	18	21
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	1	11	6	17	---	---	---	2	10	1	3	2	1	3	---	4	3
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	14	40	89	93	136	92	50	229	164	127	76	35	151	51
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	6	17	7	20	19	21	7	34	27	36	3	13	38	8
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5	15	3	---	3	---	---	---	---	---	---	---	---
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---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	1	---	1	3	---	3	8	10
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	5	---	1	3	10	4	2	18	7
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	8	2	5	4	4	47	10
---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	?1	---	---	---	---	2
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---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	4	7	---
7	1167	159	15	810	80	92	56	702	108	241	356	578	1016	1011	494	373	257	517	547	663	521	206	382	309	803	682	169	551	497	485	155	171	834	219

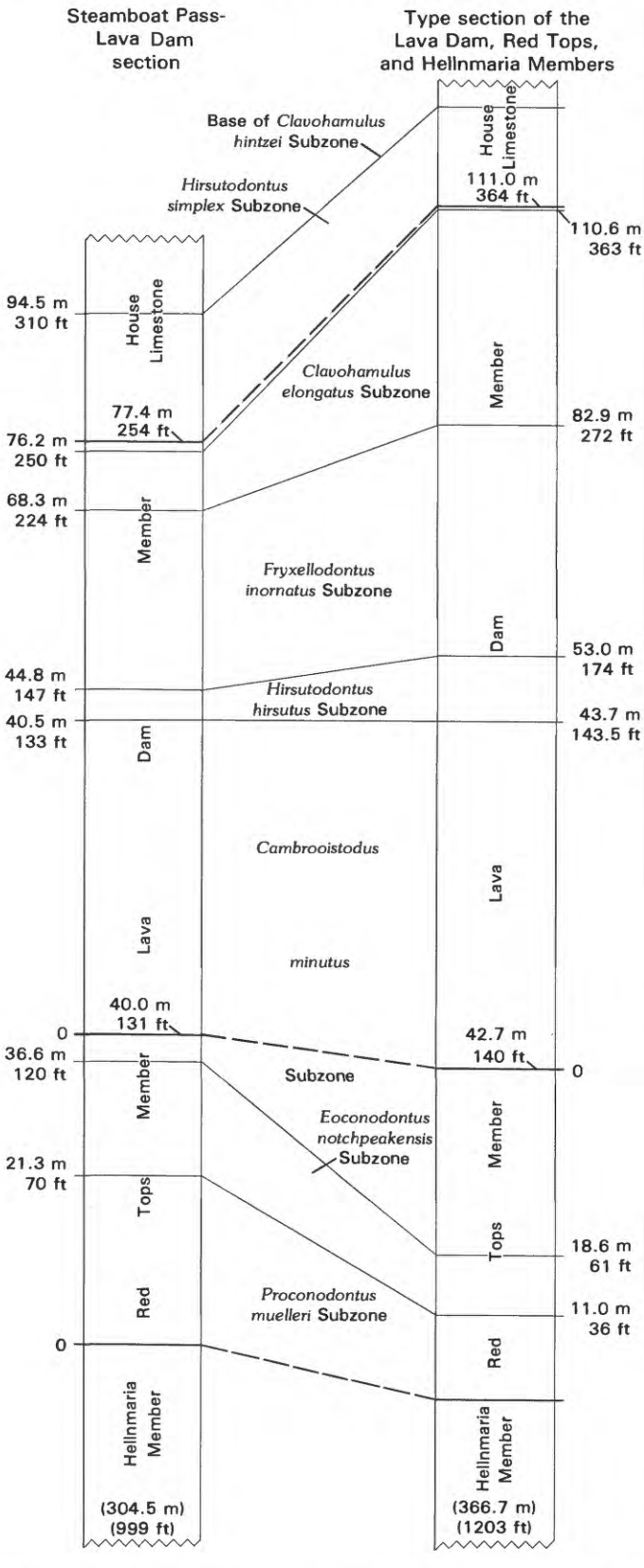

FIGURE 6.—Correlation of lithostratigraphic and some conodont biostratigraphic units between the Steamboat Pass-Lava Dam section and principal reference section of the Notch Peak Formation. Numbers indicate feet and meters above base of units for various boundaries shown.

A similar relationship occurs in other nearby sections not reported here, suggesting that this stratigraphic boundary may be nearly isochronous in the study area.

TRILOBITES

Notch Peak Formation has yielded trilobites from the House Range area that are as old as the late Franconian *Taenicephalus* Zone and as young as the Early Ordovician (early Canadian age) *Symphysurina* Zone. Some parts of the Notch Peak Formation, particularly the Hellnmaria Member, have yielded few or no trilobites so that some of the intervening trilobite zones have not been recognized in the House Range area. Occurrences and ranges of trilobites in the Notch Peak Formation are given in table 4 and plate 1.

The most refined biostratigraphic standard of reference in North America for trilobites of late Franconian through earliest Ordovician age was developed through detailed studies of the Wilberns Formation of central Texas (Bell and Ellinwood, 1962; Winston and Nicholls, 1967; Longacre, 1970; Barnes and Bell, 1977) and equivalent rocks in Oklahoma (Stitt, 1971, 1977, 1983). The zonal scheme developed in these areas, with somewhat modified nomenclature, is given in figure 4.

Taenicephalus Zone.—The *Taenicephalus* Zone can be divided into a lower *Parabolinoides* Subzone and an upper unnamed subzone characterized by the presence of *Orygmaspis* and *Taenicephalus*, and absence of *Parabolinoides*. The upper part of the Sneakover Limestone Member of the Orr Formation, which immediately underlies the Hellnmaria Member of the Notch Peak Formation, has yielded *Parabolinoides* sp. in the Lawson Cove section (7668-CO), Wah Wah Mountains; in the Steamboat Pass-Lava Dam section, southern House Range; and in Big Horse Canyon (7669-CO), Candland Canyon-Little Valley section (8243-CO), central House Range (fig. 3). One sample (D2831-CO) from 20.4 m above the base of the Hellnmaria Member (pl. 1) contains *Taenicephalus* sp. and *Billingsella* sp. These data show that the contact between the Sneakover Limestone Member of the Orr Formation and the Hellnmaria Member of the Notch Peak Formation occurs within the *Taenicephalus* Zone, and may occur near the boundary between the lower and upper parts of the zone.

Idahoia Zone.—One other trilobite sample is known from the Hellnmaria Member. The sample (8343-CO) was collected from outcrops just above valley alluvium

about 150 m north of U.S. Highway 50 in an unsurveyed area 7.8 km east of the road intersection on the east side of Skull Rock Pass, Notch Peak quadrangle, Utah. The sample contains the following taxa:

Trilobites:
Drumaspis cf. *D. walcotti* Resser
Idahoia sp.
Pseudagnostus sp.
Taenicephalina(?) sp.
cf. *Wilbernia* sp.
Conodonts:
Prooneotodus gallatini (Müller)
P. rotundatus (Druce and Jones)
Phakelodus tenuis (Müller)
Brachiopods:
Billingsella(?) sp.
Angulotreta vescula Grant
Linguloid, gen. and sp. undet.

The sample is assigned to the *Drumaspis* Subzone of the *Idahoia* Zone, upper Franconian Stage.

The uppermost Franconian *Ellipsocephaloides* Zone of Longacre (1970), here considered a subzone of the *Idahoia* Zone, has not been recognized in the Notch Peak Formation. However, the zone is known to occur in the lower part of the Whipple Cave Formation, which is a facies equivalent of the Hellnmaria Member in east-central Nevada (Taylor and Cook, 1976, text-fig. 2). The position of the *Ellipsocephaloides* Subzone, and of the overlying *Saukiella pyrene* Subzone of the *Saukia* Zone in the Steamboat Pass-Lava Dam Section (pl. 1) are probably occupied by the upper part of the Hellnmaria Member, which has not yielded trilobites.

Saukia Zone.—The *Saukia* Zone has been divided into four subzones (Winston and Nicholls, 1967; Longacre, 1970; Stitt, 1971) that are recognizable in sites of platform carbonate deposition around the North American craton (Taylor and Halley, 1974). The lowest subzone, the *Saukiella pyrene* Subzone, has not been recognized in the Notch Peak Formation although it is present in eastern Nevada (Taylor and Cook, 1976, p. 184).

The lowest identifiable trilobites above the dolomites of the upper Hellnmaria Member occur in bioclastic limestones of the Red Tops Member (pl. 1). These trilobites are assigned to the *Saukiella junia* Subzone on the basis of the joint occurrence of *Euptychaspis typicalis* Ulrich, *Eurekia* n. sp. A, and *Saukiella pepinensis* (Owen).

The stratigraphic position of the top of the *S. junia* Subzone is uncertain. No diagnostic trilobite samples have been recovered in place from a 24.4-m-thick interval between 7.6 m below the top of the Red Tops Member and 16.8 m above the base of the Lava Dam Member. However, conodont data (Miller and others, 1982) from the Wilberns Formation in central Texas and the Signal Mountain Limestone in Oklahoma show that the base of the *Cambrooistodus minutus* Subzone of the *Proconodontus* Zone occurs near the base of the *Saukiella serotina* Subzone in those areas. In the Steamboat Pass-Lava Dam section, the base of the *Cambrooistodus minutus* Subzone is at 3.4 m below the top of the Red Tops Member, which is approximately 20.1 m below the lowest recognized trilobite assemblages assigned to the *Saukiella serotina* Subzone. For this reason the stratigraphic interval between highest definite *S. junia* trilobite assemblages and lowest definite *S. serotina* Subzone assemblages is assigned with question to the *S. serotina* Subzone (see pl. 1).

The *Saukiella serotina* Subzone is recognized in the Steamboat Pass-Lava Dam section by the occurrence of *Euptychaspis kirki* Kobayashi, *Macronoda* sp., *Heterocaryon tuberculatum* Rasetti, and *Leiocoryphe platycephala* Kobayashi. The base of the zone is at least as low as 16.8 m above the base of the Lava Dam Member, but may occur as low as 7.6 m below the top of the Red Tops Member (see further discussion under "*Saukiella junia* Subzone"). The top of the *S. serotina* Subzone occurs between 39.6 m and 40.5 m above the base of the Lava Dam Member.

The *Eurekia apopsis* Subzone (= *Corbinia apopsis* Subzone of authors) is recognized by the occurrence of *Eurekia apopsis* (Winston and Nicholls), *Acheilops masonensis* Winston and Nicholls, *Larifugula leonensis* (Winston and Nicholls), and *Triarthropsis nitida* Ulrich. The lowest trilobite collections assigned to the *E. apopsis* Subzone occur at 40.5 m above the base of the Lava Dam Member, whereas the highest collections are from 41.8 m above the base of the member.

The boundary between the *Eurekia apopsis* Subzone of the *Saukia* Zone and base of the overlying *Missisquoia depressa* Subzone of the *Missisquoia* Zone is generally recognized as the Cambrian-Ordovician boundary in North America (Winston and Nicholls, 1967; Stitt, 1971, 1977; Taylor and Halley, 1974; Landing and others, 1978; Miller and others, 1982). The boundary occurs in the Steamboat Pass-Lava Dam section within a 1.5-m-thick interval between 41.8 and 43.3 m above the base of the Lava Dam Member. The boundary interval is within the *Hirsutodontus hirsutus* Subzone of the *Cordylodus proavus* Zone, and is not marked by changes in the known conodont faunas.

Missisquoia Zone.—The *Missisquoia* Zone was named by Winston and Nicholls (1967) for some characteristic trilobite assemblages in the upper part of the Wilberns Formation in central Texas. Derby and others (1972) redefined the *Missisquoia* Zone to include those faunas above the *Saukia* Zone and below the lowest occurrence of *Symphysurina* in the Survey Peak Formation, southern Alberta, Canada. This restricted the zone so as to

TABLE 4.—*Occurrences of trilobites and some other fossils in the Steamboat Pass-Lava Dam section of the Notch Peak Formation and House Limestone, southern House Range, Utah*

[Locality numbers are USGS (U.S. Geological Survey) catalog numbers of samples stored at the Denver Federal Center, Denver, Colo. Stratigraphic position is indicated in meters above the base of lithostratigraphic unit. A range chart is given in plate 1. x, occurrence; ?, occurrence of taxon questionably identified; cf., taxonomic identification probable.]

Rock unit	Orr Formation	Notch Peak Formation																				House Limestone		
	Sneakover Limestone Member (46.6 m)	Hellnmerie Member (304 m)	Red Tops Member (40 m)								Lava Dam Member (77.4 m)													
Meters above base of member	25.3	26.5	20.4	228.3	229.8	240.5	9.1	20.4	21.9	22.9	23.5	25.0	29.6	30.8	32.3	38.1	16.8	22.9	23.8	27.7	30.8	39.6	40.5	40.5	40.5	41.5	41.8	43.3	44.8	45.7	45.9	74.4	77.3	77.4	0.3	0.9	6.7
Locality number	D2829-CO	D2830-CO	D2831-CO	5497-CO	5844-CO	5813-CO	5498-CO	5499-CO	D2813-CO	D2797-CO	D2814-CO	5500-CO	D2798-CO	D2815-CO	D2799-CO	D2816-CO	D2800-CO	D2802-CO	D2817-CO	8093-CO	D2803-CO	D2818-CO	D2804-CO	8095-CO	D2806-CO	D2819-CO	8096-CO	D2807-CO	D2810-CO	D2811-CO	D2820-CO	D2809-CO	D2822-CO	D2824-CO	D2823-CO	D2812-CO	D2825-CO	D2827-CO
Trilobites:																																					
Elvinia sp.	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Comanchia sp.	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Irvingella flohri Resser	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Taenicephalus sp.	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bayfieldia sp. A	---	---	---	---	---	---	x	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bowmania sp.	---	---	---	---	---	---	x	---	x	---	---	---	x	---	---	---	---	x	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Euptychaspis typicalis Ulrich	---	---	---	---	---	---	x	x	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Prosaukia sp.	---	---	---	---	---	---	x	x	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bowmania n. sp. A	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Eurekia n. sp. A	---	---	---	---	---	---	---	x	x	x	x	---	x	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Illaenurus sp.	---	---	---	---	---	---	---	x	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Saukiella sp.	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Saukia sp.	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Monocheilus sp.	---	---	---	---	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Idiomesus sp.	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Briscoia sp.	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Plethometopus sp.	---	---	---	---	---	---	---	---	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	x	---	---	---	---	---	---	---	---	---
Saukiella pepinensis (Owen)	---	---	---	---	---	---	---	---	---	x	---	---	cf.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Eurekia eos (Hall)	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	cf.	---	x	x	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Euptychaspis sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Leiocoryphe sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bayfieldia simata Winston and Nicholls	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Heterocaryon sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	?	?	---	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
New genus & species A	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Leiocoryphe n. sp. A	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Leiocoryphe n. sp. B	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Acheilops n. sp. A	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Eurekia sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Euptychaspis kirki Kobayashi	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	x	---	x	x	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Macronoda sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	?	x	x	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Eurekia sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---
Bayfieldia sp.	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	x	---	cf.	?	?	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---	---

Stenopilus bacca Resser	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Acidaspis ulrichi Bassler	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x --- --- x	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Heterocaryon tuberculatum Rasetti	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x --- x x	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Rasettia wichitaensis (Resser)	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ? --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Idiomesus intermedius Rasetti	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- x x	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Stenopilus latus Ulrich	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- cf.	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Leiocoryphe platycephala Kobayashi	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	x --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Stenopilus sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	x --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Eurekia apopsis (Winston and Nicholls)	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- cf ? x x	x cf x --- ---	--- --- --- --- ---	--- --- ---
Acheilops masonensis Winston and Nicholls	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x --- --- ---	x --- --- --- ---	--- --- --- --- ---	--- --- ---
Triarthropsis sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- ? --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Larifugula leonensis (Winston and Nicholls)	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	x --- --- --- ---	--- --- --- --- ---	--- --- ---
Triarthropsis nitida Ulrich	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	cf --- --- --- ---	--- --- --- --- ---	--- --- ---
Triarthropsis princetonensis Kobayashi	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	cf --- --- --- ---	--- --- --- --- ---	--- --- ---
Plethometopus armatus (Billings)	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- cf ---	--- --- --- --- ---	--- --- ---
Missisquoia depressa Stitt	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- ---
Missisquoia typicalis Shaw	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- x	cf x x --- ---	--- --- ---
Highgatella cordilleri (Lochman)	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- x --- x	--- --- ---
Hystricurus sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- cf. x x	x --- ---
Symphysurina brevispicata Hintze	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- x --- ---	--- --- ---
Missisquoia inflata Winston and Nicholls	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- cf ---	--- --- ---
Highgatella sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- ? ---	--- --- ---
Symphysurina bubops Winston and Nicholls	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- x	x --- ---
Symphysurina sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	x ? cf
Apatokephaloid, undet.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	x --- ---
Brachiopods:									
Billingsella	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Orthoids, gen. and sp. undet.	--- ---	--- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- x	x x --- --- x	x --- ---
Inarticulates, gen. and sp. undet.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x --- --- ---	--- --- --- --- ---	x --- --- --- ---	--- --- --- --- ---	x --- ---
Mollusks:									
Kygmaeoceras sp.	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- ? --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Matthevia sp.	--- ---	--- x x x	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Owenella sp.	--- ---	--- --- --- ---	--- --- --- x ---	--- x --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Chiton?	--- ---	--- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Gastropod, low-spired dextral	--- ---	--- --- --- ---	--- x --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- x x ---	--- x x --- x	x --- --- --- ---	--- --- ---
Gastropod, high-spired dextral	--- ---	--- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- x	--- --- --- --- ---	--- --- --- --- ---	--- x --- --- ---	--- --- ---
Gastropod, high-spired sinistral	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Nautiloid cephalopod?	--- ---	--- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Other:									
Echinodermal columnals	--- ---	--- --- --- ---	--- --- --- x x	--- --- x x x	--- x x x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- x	x --- ---
Echinodermal frame plates	--- ---	--- --- --- ---	--- --- --- x x	--- x x x ---	--- x x x ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---
Hyolithoids	--- ---	--- --- --- ---	--- x --- x x	--- --- x --- ---	--- --- --- --- ---	--- --- --- --- ---	--- x x --- ---	--- --- --- --- ---	--- --- ---
Sponge spicules	--- ---	x --- --- ---	x --- --- --- ---	x --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- --- --- ---	--- --- ---

exclude the lower range of *Symphysurina*, which had been included in the zone by the original definition (Winston and Nicholls, 1967).

Based on meticulously detailed collecting in the Signal Mountain Limestone in Oklahoma, Stitt (1977, pl. 7) refined and divided the zone into a lower *Missisquoia depressa* Subzone and an upper *Missisquoia typicalis* Subzone. Both subzones can be recognized in the Notch Peak Formation. The *M. depressa* Subzone is recognized at one horizon (D2810-CO) 43.3 m above the base of the Lava Dam Member in the Steamboat Pass-Lava Dam section (pl. 1). The sample contains *Missisquoia depressa* Stitt, *Plethometopus armatus* (Billings), and a single indeterminate olenid free cheek.

The *Missisquoia typicalis* Subzone is recognized in the Steamboat Pass-Lava Dam section by the occurrence of *Missisquoia typicalis* Shaw. The subzone extends between 44.8 m and 74.4 m above the base of the Lava Dam Member (pl. 1). The top of the zone is defined by the lowest occurrence of *Symphysurina brevispicata*.

Symphysurina Zone.—Lower Ordovician rocks in the western United States were initially divided by Ross (1949, 1951) into a scheme of trilobite assemblage zones designated by the letters A to M in the Garden City and Swan Peak Formations of southeastern Idaho and northeastern Utah. Hintze (1951, 1952) applied the Ross zonal scheme, with some emendations, to the Pogonip Group in the House Range-Ibex area of western Utah, the area of the present study. Hintze (1952, p. 5) did not recognize Zone A of Ross; instead he assigned his lowest Ordovician trilobite assemblage to Zone B which he called the *Symphysurina* Zone. Hintze's (1952, p. 7) *Symphysurina* Zone consists of a lower part characterized by *Hystricurus millardensis* Hintze and *Symphysurina brevispicata* Hintze, and an upper part that contains different species of *Hystricurus* and *Symphysurina* in association with species of *Clelandia*, *Xenostegium*, and *Bellefontia*. Taylor and Landing (1982) showed that trilobite Zone B of Hintze (1951) correlates with trilobite Zones A and B of Ross (1949) and some older beds assigned to lower parts of the *Symphysurina* Zone that are missing from the Bear River Range section because of a disconformity between the St. Charles and Garden City Formations.

Stitt (1977) studied trilobite collections from the Signal Mountain Limestone of the Wichita Mountains, Oklahoma, and divided the *Symphysurina* Zone into a lower *Symphysurina brevispicata* Subzone and an upper *Symphysurina bulbosa* Subzone. Stitt (1977, p. 32–36, pl. 7) defined the base of the *Symphysurina brevispicata* Subzone on the lowest occurrence of *Symphysurina brevispicata* Hintze and *Highgatella cordilleri* (Lochman). The overlying *S. bulbosa* Subzone is defined by the lowest occurrence of *S. bulbosa* Lochman. As so defined, the *Symphysurina brevispicata* Subzone of the *Symphysurina* Zone can be recognized in the Steamboat Pass-Lava Dam section beginning 74.4 m above the base of the Lava Dam Member (equals 3.0 m below top of Notch Peak Formation).

Hintze's Ibex section B (Hintze, 1951, p. 33–37; 1952, p. 25, 26) was measured about 2.4 km north of the Lava Dam segment of the Steamboat Pass-Lava Dam section reported here. He reported a trilobite fauna from 2.1 m above the base of the House Limestone that contains *Hystricurus millardensis*, *Symphysurina brevispicata*, *Symphysurina* cf. *S. cleora* (Walcott), and some nontrilobite fossils. This assemblage shows affinity with the *S. brevispicata* Subzone as defined by Stitt (1977) and, together with new trilobite data reported here (table 4, pl. 1), suggests that the *S. brevispicata* Subzone spans the boundary between the Notch Peak and House Formations.

The position of the top of the *Symphysurina brevispicata* Subzone is uncertain in the House Range-Ibex area, but probably is no higher than 33.5 m above the base of the House Limestone in Ibex section B (Hintze, 1951, p. 36; 1952, p. 26) where *Bellefontia* sp. occurs. *Bellefontia* is typical of the upper part of the *Symphysurina* Zone that is approximately equal to Zone B of Ross (1951).

MEASURED SECTIONS OF THE NOTCH PEAK FORMATION

TYPE SECTION OF THE NOTCH PEAK FORMATION, HOUSE RANGE, UTAH

The type locality of the Notch Peak Formation was designated by Walcott (1908a, p. 9) as the "upper portion of the main mass of Notch Peak," and his described section was measured (Walcott, 1908b, p. 173) "on the east and southeast slopes and ridges of Notch Peak." Walcott did not designate a stratigraphic boundary at the top of the formation, apparently taking the uppermost beds on Notch Peak as the highest unit he measured. Hintze (1951, 1973) defined the top of the Notch Peak Formation by identifying its stratigraphic contact with the base of the overlying House Limestone in the type section for that formation 8 km south of Notch Peak. The base of the Notch Peak Formation was designated by Walcott at its contact with the Orr Formation, which was redescribed by Hintze and Palmer (1976).

The geologic map of the Notch Peak quadrangle (Hintze, 1974a) shows the contacts of the Notch Peak Formation with the Orr Formation and House Limestone in accordance with the present definitions. The

map shows that strata on Notch Peak itself have been recrystallized by contact metamorphism associated with a granitic intrusion a few kilometers north of the peak. Because of the uncertainty of the exact location of Walcott's original measured section and because of the metamorphism on the peak itself, designation of a principal reference section for the Notch Peak Formation is warranted. Because of faulting, the formation cannot be traversed in a single unbroken section. The segments were selected on the basis of completeness of exposure and ease of accessibility. They are located (fig. 7) on the ridges southeast of Notch Peak and thus fall within the locale originally designated by Walcott.

REFERENCE SECTIONS OF THE NOTCH PEAK FORMATION

Principal reference section for the Notch Peak Formation and the type sections for its Hellnmaria, Red Tops, and Lava Dam Members, Central House Range, Utah

Type section for the basal part of the Hellnmaria Member is located in SE1/4 sec. 35, T. 19 S., R. 13 W. The type for the remainder of the Hellnmaria Member was measured in two segments in sec. 2, T. 20 S., R. 13 W., as shown in figure 7. The type section for the Red Tops and Lava Dam Members were measured in sec. 5, T. 20 S., R. 13 W. as shown on figure 7.

The Notch Peak Formation in its type area conformably overlies the Orr Formation and conformably underlies the House Limestone. Massive basal limestones and dolomites of the Notch Peak form nearly vertical cliffs above the ledges of the upper part of the Orr Formation. Similarly, bold cliffs of the Lava Dam Member stand in contrast with the topographic expression of the stairstep ledges of the overlying House Limestone.

Detailed faunal data are given in figure 5 and table 1. Conodonts listed in the section were identified by J. F. Miller; Cambrian trilobites were identified by M. E. Taylor, Ordovician trilobites by L. F. Hintze and M. E. Taylor; Lava Dam and Red Tops Members were described by J. F. Miller; the Hellnmaria Member was described by L. F. Hintze.

House Limestone

Unit		Thickness (Meters)	Thickness (Feet)
31.	Lime mudstone, medium-gray, thin- to thick-bedded, includes 10–30 percent brown chert in irregularly bedded masses; forms ledges above cliffs at top of Notch Peak Formation. *Symphysurina* was identified from bioclastic lens at the base of the unit, and from scattered disarticulated silicified fragments at the top of the unit	15.1	50

Notch Peak Formation (principal reference section)

Lava Dam Member (type section)

Unit		Thickness (Meters)	Thickness (Feet)
30.	Stromatolitic limestone, medium-gray, massive. Algal stromatolites range from 15 to 30 cm across and 60 to 100 cm in height. Unit mostly composed of hemispherical stromatolites with lime grainstone filling interstices. Includes a few thin beds of lime mudstone and minor chert. Forms massive rounded cliff	58.4	192
29.	Lime mudstone, medium-dark-gray, cherty; forms ledge	4.0	13
28.	Covered	1.2	4
27.	Lime mudstone, light- to dark-gray; forms ledges	2.2	7
26.	Oolitic lime grainstone. Fault with about 7 m vertical offset repeats oolite along section traverse	0.6	2
25.	Lime mudstone, medium-gray, cherty; forms ledges more prominent than unit below. Upper 2 m poorly exposed	18.2	60
24.	Lime mudstone, medium-dark-gray, thin- to medium-bedded, includes 5 percent chert as small irregularly bedded masses in the middle one-third of the unit. Forms ledges mostly less than 1 m high, but includes basal ledges as much as 3 m high and ledges near the middle and top as much as 6 m high. Occasional thin beds of lime grainstone are present. The contact between Red Tops and Lava Dam Members is placed at the change from brown-weathering grainstone of the Red Tops to gray lime mudstone of the Lava Dam. Topographic contrast accompanies the lithologic change. The Red Tops Member forms a bench or slope, and the Lava Dam Member forms ledges and cliffs	26.3	86
	Total thickness of Lava Dam Member	110.9	364

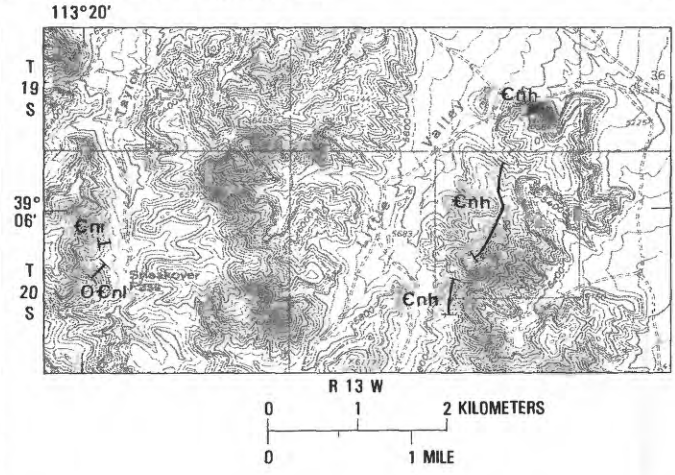

FIGURE 7.—Principal reference section of the Notch Peak Formation in the central House Range, Utah, as located on the Notch Peak 15-minute quadrangle. Last letter of the geologic symbol identifies the type section of each member: Cnh, Hellnmaria Member; Cnr, Red Tops Member; OCnl, Lava Dam Member.

Notch Peak Formation—*Continued*
Red Tops Member (type section)

Unit		Thickness (Meters)	Thickness (Feet)
23.	Lime grainstone and intraformational conglomerate, medium-brownish-gray; weathers shades of reddish brown; forms slopes and low ledges less than 2 m high. Uppermost ledge is 2 m below top of unit and is gray lime mudstone similar in lithology to overlying Lava Dam Member	13.1	43
22.	Intraformational conglomerate and lime grainstone, brown to gray, thin-bedded, poorly exposed; forms slope except for a low ledge 2 m above base	11.9	39
21.	Lime grainstone and intraformational conglomerate with few thin interbeds of lime mudstone, medium-brownish-gray, weathers reddish brown, thin- to medium-bedded; forms slopes and low ledges as much as 1 m high. Fragmental trilobites at 1 and 6 m above base	7.6	25
20.	Lime mudstone, medium-gray, interbedded with coarse lime grainstone that weathers reddish brown and includes thin cherty stringers. A 15-cm oolitic grainstone bed is 1.3 m below the top. Silicified trilobites and black linguloid brachiopods at 1 m above base. Unit forms prominent ledge	4.0	13
19.	Intraformational conglomerate, gray to brown	0.3	1
18.	Covered	2.1	7
17.	Lime grainstone with sparry calcite, brownish-gray, with 3 percent chert as stringers as much as 1 cm thick; 30-cm oolitic bed 3 m above base. Trilobites 3.3 m above base. Unit forms ledge at base of Red Tops Member. Contact with Hellnmaria Member placed at lithologic change from lime grainstone above to algal stromatolite below	3.7	12
	Total thickness of Red Tops Member	42.7	140

Hellnmaria Member (type section)

16.	Stromatolitic limestone, medium-gray; hemispherical stromatolites range from 15 to 60 cm across and 30 to 75 cm high; forms massive ledge	2.4	8
15.	Interbedded lime mudstone and lime grainstone, medium-dark-gray to mottled gray and brownish-gray, thin-bedded; mottled beds are partly dolomitic; a few beds show mud cracks; forms slope	9.1	30
14.	Lime mudstone, medium-dark-gray; beds are 60–120 cm thick, form low ledges	4.6	15
13.	Stromatolitic limestone, medium-dark-gray; algal heads 15–60 cm across and as much as 130 cm high; forms massive ledges and cliffs; includes 1 percent chert in thin stringers and		

Notch Peak Formation—*Continued*
Hellnmaria Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
13.	Stromatolitic limestone—*Continued* small nodules. Measured section offsets from base of this unit across fault-controlled saddle along ridge crest to triangulation station Easy	21.4	70
12.	Stromatolitic limestone, medium-dark-gray; algal heads 15–60 cm across and as much as 150 cm high; forms rounded knobs and ledges; inter-stromatolitic fillings are partly mottled olive gray, dolomitic, and include 1 percent chert	25.9	85
11.	Interbedded stromatolitic limestone and medium-crystalline limestone. Stromatolitic limestone forms 60 percent of unit in beds as much as 3 m thick; medium- to thick-bedded medium-crystalline, medium-dark-gray limestone with 5 percent chert makes up remainder. Base of this unit is elevation 5960 northeast of Easy hilltop. Offset across saddle to top of next small hill in order to continue section	33.5	110
10.	Interbedded lime grainstone and stromatolitic limestone. Medium- to coarsely crystalline, medium- to thick-bedded, medium-dark-gray lime grainstone makes up 60 percent of unit. Algal stromatolites make up 40 percent including basal 2 m. Poorly preserved *Matthevia* 21 m above base	44.2	145
9.	Lime mudstone, medium-dark-gray, with 5 percent chert as dark-brown bedded nodules. Silicified *Matthevia* 2 m above base. Thin bed of oncolites 8 m above base	12.2	40
8.	Lime grainstone, medium-dark-gray, medium- to coarsely crystalline, thick-bedded to massive, forms smooth slope; contains small irregular markings that suggest fossil traces but nothing is identifiable; includes 5 percent chert	29.0	95
7.	Lime grainstone, medium-gray, medium- to coarsely crystalline, medium- to thick-bedded, with 5 percent chert; forms level terrain along traverse. Fragmental trilobites in coarsely crystalline limestone bed 8 m above base	13.7	45
6.	Limestone, medium-gray, fine- to medium-crystalline, massive, contains 1 percent chert, unfossiliferous; forms ledge	15.3	50
5.	Limestone, medium-dark-gray, finely crystalline, with 6 percent chert as irregularly bedded masses, unfossiliferous, forms ledges. Section offsets northward 400 m across fault and dip slope to continue on north end of hill 5843	12.1	40
4.	Limestone, medium- to medium-dark-gray, medium- to finely crystalline,		

North Peak Formation—*Continued*
Hellnmaria Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
4.	Limestone—*Continued* massive, contains 2–5 percent dark-brown chert as discontinuous irregular bedded masses as much as 5 cm thick and 15 cm long. Bedding in unit is marked by slight color changes and by chert masses. One 15-cm bed of oolites and pisolites occurs in middle of unit. No skeletal fossils found. Forms cliffs and ledges	109.7	360
3.	Limestone, medium- to medium-dark-gray, finely crystalline, uneven bedding, contains 2–5 percent chert as discontinuous irregular dark-brown masses on some bedding surfaces, unfossiliferous, forms cliff. Contact with underlying Orr Formation is conformable and is marked by transition from ledge-slope to cliff topographic expression	33.5	110
	Total thickness of Hellnmaria Member	366.7	1203
	Total thickness of Notch Peak Formation	520.3	1707
	Contact conformable		

Orr Formation
Sneakover Limestone Member

2.	Limestone, medium-dark-gray, medium- to finely crystalline, forms ledges 0.6–1.2 m high, distinctive pink silty material on irregular bedding surface; phosphatic brachiopods common in upper third along with 5 percent dark-brown chert as thin irregularly bedded masses. Silicified *Eoorthis* rare 3 m above base	28.3	96
1.	Limestone, medium-light-gray, coarse to medium-crystalline, forms ledges 0.6–1.5 m high, some beds with fragmental trilobites. Base of measured section is where limestones are covered by alluvium	18.9	62

Steamboat Pass-Lava Dam section, southern House Range, Utah

Because of faulting (see Hintze, 1974b), the section was traversed in segments selected for optimum exposure. Base of section is in the NW1/4 sec. 19, T. 23 S., R. 13 W., as shown on The Barn 15-minute quadrangle (fig. 8). The middle and upper parts of the Hellnmaria Member and the Red Tops Member were measured in sec. 18 as shown on figure 8. The Lava Dam Member was measured in the south half of sec. 6 and the north half of sec. 7, T. 23 S., R. 13 W. (fig. 8). A geologic map of the Lava Dam area and general position of the Lava Dam segment of the traverse is given in figure 9. Detailed faunal data are given in tables 2, 3, and 4, and plate 1. Conodonts were identified by J. F. Miller, trilobites were identified by M. E. Taylor, and mollusks were identified by M. E. Taylor and E. L. Yochelson. The section was measured and described by J. F. Miller and L. F. Hintze with emendations by M. E. Taylor.

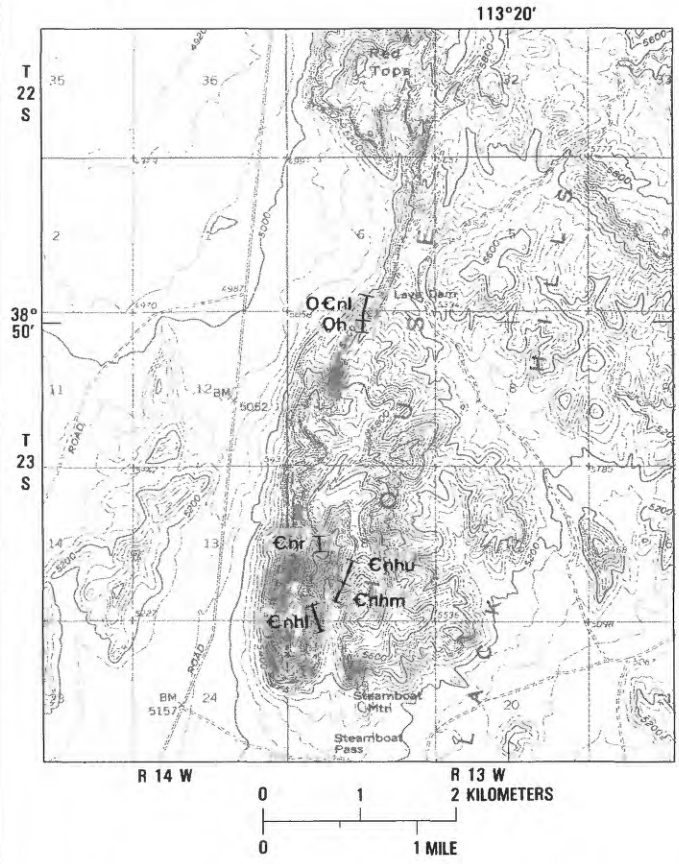

FIGURE 8.—Steamboat Pass-Lava Dam reference section of the Notch Peak Formation, southern House Range, as located on The Barn 15-minute quadrangle, Utah. Last letter of the geologic symbol identifies the member or map unit: Єnhl, lower map unit of the Hellnmaria Member; Єnhm, middle map unit of the Hellnmaria Member; Єnhu, upper map unit of the Hellnmaria Member; Єnr, Red Tops Member; OЄnl, Lava Dam Member; Oh, House Limestone.

House Limestone (upper part eroded)

Unit		Thickness (Meters)	Thickness (Feet)
41.	Lime mudstone, medium-gray, with 20 percent bedded chert. Chert darker and more evenly bedded than unit below. Unit forms steplike ledges to top of hill	18.3	60
40.	Arenaceous limestone and skeletal lime grainstone, medium-gray and brownish-gray, some silty beds. Admixed quartz sand, fine grained. 30 percent bedded chert, light- to dark-brownish-gray, some nodular chert. Unit forms upper part of cliff	7.9	26
	Exposed thickness of House Limestone	26.2	86

Notch Peak Formation
Lava Dam Member

39.	Lime mudstone, medium-gray, forming massive main cliff in upper part of member. 5–10 percent nodular bedded chert and chert stringers. Prominent		

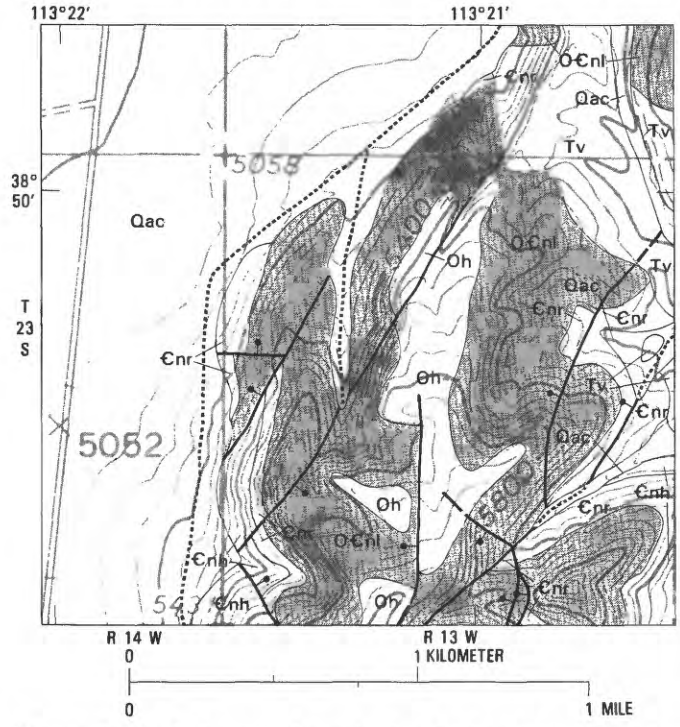

FIGURE 9.—Geologic map of area in the vicinity of the Steamboat Pass-Lava Dam reference section of the Notch Peak Formation, Utah. V's show the path of the measured section. Qac, Quaternary alluvium and colluvium; Tv, Tertiary volcanic rocks; Oh, Ordovician House Limestone; OCnl, Lava Dam Member of the Notch Peak Formation; Cnr, Red Tops Member of the Notch Peak Formation; Cnh, Hellnmaria Member of the Notch Peak Formation. Geology modified from Hintze (1974b).

Notch Peak Formation—*Continued*
Lava Dam Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
39.	Lime mudstone—*Continued* break in slope at top of unit. Traverse offset 12 m to east across fault at base of unit	28.7	94
38.	Lime mudstone, medium- to light-gray, mottled brown to pink, slightly cherty, oncolitic, burrowed. Ledge at 46–47.9 m, covered from 47.9–48.8 m	2.7	9
37.	Lime grainstone, pebbly, oolitic, light-gray, with minor chert, interbedded with cherty and noncherty, dense lime mudstone and lime wackestone. Oolite from 40.5–42.1 m, lime mudstone and wackestone 42.1–43.3 m. Prominent ledge 40.5–43.3 m. At 43.6 m oolitic lime grainstone bed with granules and fine pebbles. Covered 43.6–43.9 m. Cherty lime mudstone and wackestone 43.9–45.7 m, 45.1–45.7 m possibly poorly laminated, high-relief stromatolites. White chert bed 5–15 cm thick forms marker bed at 45.1 m. Oolitic and pebbly lime grainstone 45.9–46.0 m containing abundant orthoid brachiopods and trilobites	5.5	18
36.	Lime mudstone, medium- to dark-gray, some ledges cherty. Unit forms prominent ledges, thicker than ledges in 16.8 m thick unit below. Prominent ledge 29.0–30.5 m, top forms large flat bench. At 30.8 m partly silicified *Euptychaspis* fauna in several 7-cm thick, very dense lime mudstone beds. Thin-bedded, very argillaceous and highly burrowed lime mudstone 30.8–31.1 m. Four prominent ledges in upper part of unit, top three ledges cherty. Covered slope 39.6–40.2 m. Lime mudstone bed at 40.2–40.5 m	11.6	38
35.	Lime mudstone, medium- to dark-gray, some weathering brown; cherty, forms low ledges 2–7 cm thick with thinly covered slopes. Ledges thinner than in unit below. Between 19.8 m and 21.3 m cross small fault and repeat 0.9 m of section	15.8	52
34.	Lime mudstone, medium-gray, minor chert, forms four prominent ledges. Cherty ledge 10.7–12.2 m, covered 8.8–10.7 m; ledge with argillaceous partings 7.9–8.8 m covered 6.7–7.9 m. Prominent cherty ledge 2.7–6.7 m, covered 2.1–2.7 m. Basal 2-m thick ledge cherty with abundant burrows at 1 m; fossil debris and minor flat pebble conglomerate at 2.1 m	12.2	40
	Total thickness Lava Dam Member	77.4	254

Red Tops Member

33.	Lime grainstone with thin beds of intraformational conglomerate, medium-brownish-gray, partly covered slope	3.0	10
32.	Lime mudstone, medium-gray, minor chert, forms ledge similar to those in Lava Dam Member	1.2	4
31.	Limestone, interbedded grainstone, wackestone and intraformational conglomerate, gray to brown, with less than 2 percent chert; forms low ledges and slopes, upper part poorly exposed. Grainstones include abundant trilobite debris, especially near base	5.5	18
30.	Stromatolitic limestone, medium-gray, individual algal heads as much as 20 cm across. Forms a bioherm 3–5 m across surrounded by lime grainstone and wackestone. Other similar mounds nearby	1.8	6
29.	Limestone, light-brown to gray, grainstone and wackestone, mostly trilobite debris, thin-bedded, with silty partings, some twiggy bodies and minor chert	4.0	13
28.	Limestone, medium-gray to brownish-gray, weathers to reddish- and yellowish-gray, mostly grainstone and wackestone,		

Notch Peak Formation—*Continued*
Red Tops Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
28.	Limestone—*Continued* including much trilobite debris, thin- to medium-bedded; forms low ledges. Thin oolitic horizons at 3, 4, and 5 m above base and a thicker oolitic zone from 7 to 10 m above base. A few beds include intraformational conglomerate and some contain minor chert nodules. Well-preserved trilobites at base and 2 m below top	11.0	36
27.	Limestone, medium- to dark-gray, medium-bedded. Interbedded medium-grained lime mudstone, lime wackestone, and skeletal grainstone with minor chert as stringers and nodules. Pinkish- and yellowish-brown silt marks mottled partings. Pisolites are included in beds near the top and 6 m above the base and near base of unit. Forms low ledges, makes a conspicuous dark-gray band between the brown-weathering units above and the lighter gray upper Hellnmaria beds below. Well-preserved trilobites about 10 m above base. Contact with Hellnmaria Member is conformable and marked by changes from light-gray, massive stromatolitic limestone below to darker gray thinner bedded clastic limestones above. Contact is undulatory but sharp	13.4	44
	Total thickness of Red Tops Member	39.9	131
	Hellnmaria Member—upper map unit (Hintze, 1974b)		
26.	Stromatolitic limestone, light-gray; composed mostly of algal heads 15–30 cm in diameter with fine-grained lime mudstone between, forms rounded cliffs and smooth slopes	22.9	75
25.	Dolomite, alternating light- and dark-gray beds, some relict algal stromatolite structures, forms slopes	10.7	35
24	Stromatolitic dolomite, light-gray, forms low ledges	2.7	9
	Total thickness of upper map unit	36.3	119
	Hellnmaria Member—middle map unit (Hintze, 1974b)		
23.	Dolomite, alternating medium- and dark-gray, poorly preserved algal heads comprise about 50 percent of unit. Top of this unit is top of ledge- and cliff-forming central part of the Notch Peak Formation in the Black Hills area	11.3	37
22.	Dolomite, light-gray, composed mostly of high-relief stromatolites about 30 cm in diameter	2.7	9
21.	Dolomite, dark-gray; poorly preserved silicified gastropod shells are common	1.8	6

Notch Peak Formation—*Continued*
Hellnmaria Member—middle map unit—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
20.	Dolomite, light-gray, large algal masses, as much as 60 cm in diameter, silicified *Matthevia* common	9.8	32
19.	Dolomite, dark-gray, sugary texture, dolomitized shelly fossils and dark-colored oncolites about 2 cm in diameter give the unit a mottled appearance. Collection 60 cm above the base of the unit contains silicified *Matthevia* sp.	2.7	9
18.	Dolomite, light-gray, weathers light brownish gray, sugary texture, forms prominent light band on hill, unfossiliferous	5.5	18
17.	Dolomite, medium- to dark-gray; banded; silicified fossils common; samples 5497–CO from 1 m above base of unit and 5844–CO from 3 m above base contain *Matherella* sp., and *Matthevia* sp.	7.0	23
16.	Dolomite, dark-gray, alternating mottled and laminated, sugary texture, with 2 percent chert as nodules; forms ledges	4.9	16
15.	Dolomite, light-gray, composed entirely of high-relief stromatolites averaging 20-cm diameter; these structures resemble large mud crack polygons on weathered bedding surfaces	4.9	16
14.	Dolomite, light-gray, weathers light brownish gray, several chert bands 2–3 cm thick at top of unit; relict high-relief stromatolites common	3.0	10
13.	Dolomite, dark-gray, weathers same, interbedded laminated and mottled; poorly preserved fossil debris; 1 percent chert as bedded stringers	9.1	30
12.	Dolomite, light-gray, sugary, weathers light brownish gray	1.5	5
11.	Dolomite, dark-gray, with lighter colored relict fossil fragments; forms ledges	10.7	35
10.	Dolomite, light-gray, weathers light brownish gray; forms lowest prominent light band in darker dolomites; forms ledges	2.7	9
9.	Dolomite, dark-gray, weathers brownish gray, thin- to thick-bedded; forms ledges, some beds mottled, others thinly laminated and cross-laminated. From 8 to 10 m above the base of the unit is an intermittent black and white zebra-fabric dolomite along strike, passing laterally into dark dolomite. Silicified gastropods, *Matherella* sp., in upper two-thirds of this unit	47.6	156
8.	Dolomite, dark-gray, weathers dark brownish gray; 5 percent bedded chert as elongated nodules about 2 cm thick; some dolomite beds banded, others with fossil debris	6.1	20
7.	Dolomite, dark-brownish-gray, with interbedded white and grayish-black zebra-fabric dolomite in beds 60–120 cm thick. These lowest beds of the middle map unit		

Notch Peak Formation—*Continued*

Hellnmaria Member—middle map unit—*Continued*

Unit	Thickness (Meters)	Thickness (Feet)
7. Dolomite—*Continued* form step ledges above the more massive but rounded cliffs of the lower map unit of the Hellnmaria Member. An algal-head bed about 60 cm thick occurs 10 m above the base of this unit	22.9	75
Total thickness of middle map unit	154.2	506
Hellnmaria Member—lower map unit (Hintze, 1974b)		
6. Limestone, fine-grained lime mudstone, dark-bluish-gray, thick-bedded, 5 percent bedded chert; forms rounded cliff top. Sharp contact with overlying dolomites	19.5	64
5. Limestone, medium-grained lime mudstone, medium-gray, thick-bedded, with 10 percent bedded chert	25.9	85
4. Limestone, fine-grained lime mudstone, medium-gray, medium-bedded; forms break in cliff	6.1	20
3. Limestone, fine-grained lime mudstone, medium-gray, thick-bedded, with 10 percent bedded chert, weathers light-brownish-gray; forms cliffs	41.2	135
2. Limestone, fine- to medium-grained, medium-dark-gray, thick-bedded, with uneven "chicken-wire" bedding etched on weathered surfaces, stylolites common; forms cliffs. Contact taken at base of prominent cliffs above step ledges of Orr Formation	21.3	70
Total thickness of lower map unit	114.0	374
Total thickness of Hellnmaria Member	304.5	999
Total thickness of Notch Peak Formation	454.7	1492
Contact conformable		
Orr Formation		
Sneakover Limestone Member		
1. Lime mudstone, medium-dark-gray, medium-grained, thin-bedded; forms ledges 60–120 cm high; silty partings weather pinkish and orangish gray. Base of member covered by alluvium	21.3	70

Lawson Cove Section, Wah Wah Mountains, Utah.

This reference section is established to show the variation in thickness and lithology of members of the Notch Peak Formation as it is followed along the strike 20 km southward from the House Range sections. The lower map unit of the Hellnmaria Member can be recognized in the Wah Wah Mountains but the middle and upper map units (Hintze, 1974b), whose differentiation is based on stromatolite beds, cannot be traced into the Wah Wah Mountains probably because the stromatolite mounds were not areally extensive at any one time during Hellnmaria deposition. The bioclastic Red Tops Member

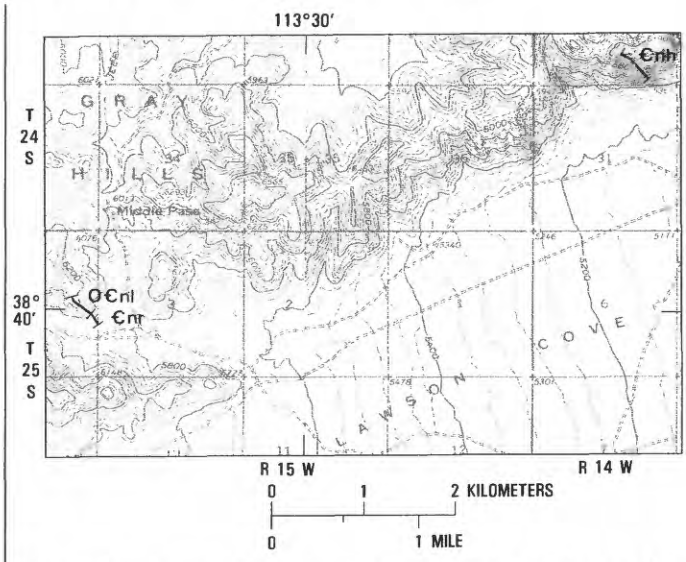

FIGURE 10.—Lawson Cove reference section of the Notch Peak Formation, Wah Wah Mountains, Utah, as located on the Wah Wah Summit and Frisco Peak 15-minute quadrangles. Last letter of the geologic symbol identifies the members: Cnh, Hellnmaria Member; Cnr, Red Tops Member; OCnl, Lava Dam Member.

persists into the northeastern edge of the Wah Wah Mountains but thins rapidly to the southwest within the range. Base of the measured section is in SW1/4 sec. 30, T. 24 S., R. 14 W. as shown on figure 10. The Red Tops and Lava Dam Members were measured in the east half of sec. 4, T. 25 S., R. 15 W. The geology of the latter area is shown on the map by Hintze (1974e). The section was measured and described by L. F. Hintze.

House Limestone

Unit	Thickness (Meters)	Thickness (Feet)
27. Limestone, medium-gray, weathers medium bluish gray, mostly siliceous calcisiltite, thin- to medium-bedded; forms low ledges capping hilltop and extending down back slope, includes less than 5 percent chert as dark-brown bedded nodules. *Symphysurina* coquina in thin horizon near base, beds mostly unfossiliferous, nonstromatolitic	137.2	450
Total thickness of House Limestone	137.2	450
Contact conformable		
Notch Peak Formation		
Lava Dam Member		
26. Stromatolitic limestone, medium-gray, algal heads 15–30 cm in diameter; forms massive ledge	1.5	5
25. Limestone, medium-gray, mostly fine- to medium-grained lime mudstone, medium- to thick-bedded; forms ledges and cliffs, includes 10–30 percent chert as light-brown to black bedded nodules	41.1	135
24. Stromatolitic limestone, medium-gray, algal heads as much as 30 cm in diameter, 60 cm high; forms massive rounded cliff	25.9	85

Notch Peak Formation—*Continued*
Lava Dam Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
23.	Lime mudstone, medium-gray, with 10 percent chert, medium-bedded; forms weak zone near base of cliffs	3.1	10
22.	Stromatolitic limestone, medium-gray; forms massive bed at base of prominent cliffs near the top of the member	3.7	12
21.	Lime mudstone, medium-gray, medium-bedded, with 10 percent chert; forms ledges averaging 120 cm high	21.3	70
20.	Lime grainstone, medium-dark-gray, medium- to coarse-grained, thin- to medium-bedded; forms low ledges. Contains fragments of partly silicified trilobites including *Euptychaspis*	16.8	55
19.	Lime grainstone, medium-dark-gray, mostly medium-grained, includes 2 percent black chert as thin-bedded bands; forms ledges averaging 1.3 m	9.1	30
18.	Lime mudstone, medium-dark-gray, medium-grained, includes 5 percent chert; forms ledges 60–120 cm high	10.7	35
	Total thickness of Lava Dam Member	133.2	437

Red Tops Member

17.	Lime grainstone, medium-gray to brownish-gray, weathers yellowish brown, mostly coarse-grained, with abundant trilobite debris, thin-bedded, slope-forming, with thin interbeds of silty lime mudstone. This unit is approximately 30 m thick at the top of Hellnmaria measured section in sec. 30, but thins to half that thickness where measured 7 km to the west in sec. 4, apparently because the lime grainstone at the top of the member passes westward into lime mudstones included in the basal Lava Dam Member	15.2	50
	Total thickness of Red Tops Member	15.2	50

Hellnmaria Member

16.	Stromatolitic limestone, medium-gray, massive; forms rounded ledges. Becomes dolomitic along strike	10.7	35
15.	Dolomite, medium-gray, medium- to coarse-crystalline, medium- to thick-bedded; forms ledges and back slope of hogback ridge near top of section	15.2	50
14.	Dolomite, medium-gray, with dark-gray bands and some thinly striped zones of white replacement dolomite, medium-crystalline. Forms outcrops from saddle to crest of small hogback ridge at top of section	36.6	120
13.	Dolomite, alternating light- and dark-brownish-gray, in thin bands, medium-crystalline, medium-bedded. Forms ledges near the top of the lower of two hogback ridges near the top of the section	10.7	35

Notch Peak Formation—*Continued*
Hellnmaria Member—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
12.	Dolomite, light-brownish-gray, dolomitized high-relief stromatolites, massive; forms ledges	16.7	55
11.	Dolomite, medium-gray to medium-brown, medium- to coarse-crystalline, with some white zebra-fabric zones of replacement dolomite, thick-bedded. Silicified *Matthevia* common. Includes 5 percent chert as brown nodules; forms ledges	24.4	80
10.	Stromatolitic limestone, medium-gray, massive, with occasional silicified *Matthevia*	10.7	35
9.	Lime mudstone, medium-gray, includes 5 percent chert; thin nodular bedding; forms slope	4.6	15
8.	Stromatolitic limestone, medium-gray, massive; forms rounded ledge	4.6	15
7.	Dolomite, medium-brownish-gray, medium-crystalline, thick-bedded, silicified *Matthevia* abundant	4.6	15
6.	Stromatolitic dolomite, medium-brownish-gray, massive	6.1	20
5.	Dolomite, mostly dark-brownish-gray, some bands light-brownish-gray, thick-bedded, with 5 percent chert as brown nodules; forms ledges	22.8	75
4.	Dolomite, light-brownish-gray, medium- to coarse-crystalline, thick-bedded; forms ledges. Shows as a conspicuous light band on aerial photographs	39.6	130
3.	Dolomite, dark-brownish-gray, coarse-crystalline, with a 2-m-thick band of zebra-fabric replacement dolomite at the base and two similar zones higher in the unit. Includes 5 percent chert. Forms prominent dark-brownish-gray cliff	67.0	220
2.	Lime mudstone, medium-gray, fine- to medium grained, thick-bedded to massive. Includes 5 percent chert as dark-brown thin stringers and bedded nodules and 2 percent argillaceous fillings of small vertical tubes 0.5 cm in diameter and 10 cm high. Forms uniform medium-gray smooth cliff probably equivalent to the "lower map unit" of the Hellnmaria Member in the southern House Range (Hintze, 1974b)	134.1	440
	Total thickness of Hellnmaria Member	408.4	1340
	Total thickness of Notch Peak Formation	556.8	1827
	Contact conformable		

Orr Formation
Sneakover Limestone Member

1.	Lime mudstone, light- to dark-gray, medium- to thick-bedded, fine- to medium-grained, with pinkish silty partings on beddings surfaces. Phosphatic brachiopods common in dark layers. Forms ledges at base of Notch Peak cliff	25.9	85
	A complete description of the Orr Formation at this locality is given in Hintze and Palmer (1976).		

Fish Springs Range section, Utah.

This reference section is described to show that the member subdivisions recognized in the House Range cannot be traced north of the House Range apparently because the bioclastic grainstones that define the Red Tops Member in the House Range are not present in the Notch Peak Formation in the Fish Springs Range. Geologic maps by Hintze (1980a,b) of the Fish Springs Range show that although the Notch Peak Formation is exposed for 25 km along the crest of the range from Fish Springs headquarters southward, it is cut by numerous faults and brecciated in many places. The exposure selected for section measurement was chosen because it is almost unfaulted and can be traversed without special climbing equipment. The measured section is located in sec. 3, T. 13 S., T. 14 W. as shown on figure 11. The section was measured and described by L. F. Hintze.

House Limestone

Unit		Thickness (Meters)	Thickness (Feet)
17.	Limestone, medium-gray, weathers medium bluish gray, siliceous, silty, with 1 percent chert as nodules in lower half increasing to 5 percent above, mostly medium- to thick-bedded. Forms step-ledges except for 10-m interval in middle which forms a cliff. *Symphysurina* in basal beds	36.6	120
	Total thickness of House Limestone	36.6	120
	Contact conformable		
Notch Peak Formation			
16.	Dolomite, very light gray, weathers light-brownish gray, coarsely crystalline, thick-bedded to massive; forms ledges and cliffs	13.7	45
15.	Dolomite, dark-gray, weathers brownish gray, medium-crystalline, thick-bedded; forms ledges	34.4	113
14.	Lime mudstone, medium-gray, silty, very thin bedded; forms reentrant	0.9	3
13.	Dolomite, medium-dark-gray, weathers brownish gray, thick-bedded, with 1 percent chert; forms ledges	17.7	58
12.	Dolomite, medium-gray, weathers light-brownish-gray, medium-crystalline, thick-bedded. Forms upper prominent light-brownish-gray band on Notch Peak cliff face when viewed from a distance	36.0	118
11.	Dolomite, dark-gray, weathers brownish gray, medium- to coarsely crystalline, includes at base a 2-m-thick pisolite marker bed, and a few mottled horizons. Forms top of dark sequence in Notch Peak cliff face	9.5	31
10.	Dolomite, medium-gray, weathers light-brownish-gray, medium-crystalline, thick-bedded to massive; forms cliffs	28.7	94
9.	Dolomite, dark-gray, weathers to brownish-gray and light-brownish-gray bands, medium-crystalline, includes 5 percent chert as prominent light-brown nodules. Zebra fabric in white and dark gray dolomite alteration zone 16 m above base. Forms cliffs	55.2	181
8.	Dolomite, light-gray, weathers light-brownish-gray, very coarsely crystalline, massive; forms cliffs	8.5	28

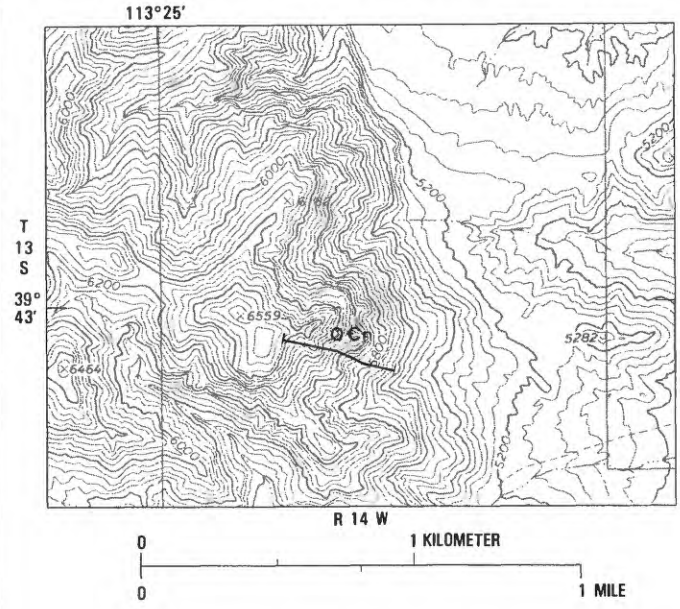

FIGURE 11.—Fish Springs Range reference section of the Notch Peak Formation, as located on the Sand Pass NW 7.5-minute quadrangle, Utah. Member divisions of the Notch Peak Formation (OCn) have not been recognized in the Fish Springs Range.

Notch Peak Formation—*Continued*

Unit		Thickness (Meters)	Thickness (Feet)
7.	Dolomite, medium-gray, weathers alternating light and dark brownish gray in broad bands, coarsely crystalline. *Matthevia* poorly preserved in dark dolomite at base	6.7	22
6.	Dolomite, medium-dark-gray, weathers brownish gray, with thin bands of lighter and darker shades, fine- to medium-crystalline, a few beds show cross-bedding, and a few thin zones of banded white vuggy secondary dolomite. Includes 1 percent chert as bedded nodules. Some horizons show thin irregular small white markings that suggest presence of fossils, but nothing identifiable. Forms cliffs	114.0	374
5.	Dolomite, dark-gray, weathers brownish gray, mostly fine-crystalline, some medium-crystalline, contains 1 percent chert as thin stringers and small nodules. Few layers with vuggy white-striped beds of replacement dolomite, replacement beds laminated light brown to dark brown, massive. Forms ledges	32.0	105
4.	Limestone, medium-dark-gray, thin-bedded with wavy partings of silty material on bedding surfaces. Forms ledges	2.1	7

Notch Peak Formation—*Continued*

Unit	Thickness (Meters)	Thickness (Feet)
3. Dolomite, dark-gray, weathers brownish gray, thin-bedded, wavy partings. Resembles upper beds of Sneakover but is dolomitic. Includes 1 percent chert. Upper 2 m is coarse-crystalline, remainder medium-crystalline. Basal contact with Sneakover is marked by sharp change from limestone to dolomite	8.5	28
Total thickness of Notch Peak Formation	367.9	1207
Contact conformable		
Orr Formation		
Sneakover Limestone Member		
2. Limestone, medium-gray to medium-dark-gray, thin-bedded, silty, with wavy partings; forms ledges and slopes. *Parabolinoides* common in thin beds 16 m below top	23.8	78
1. Limestone, light- to medium-dark-gray, coarse-crystalline in basal 4 m, fine-crystalline above. Weathers to form marker horizon of light-gray ledges made of large rectangular blocks. Contains *Elvinia* identified by A. R. Palmer	15.2	50
Total thickness of Sneakover Limestone Member	39.0	128

REFERENCES CITED

Barnes, V. E., and Bell, W. C. 1977, The Moore Hollow Group of central Texas: Bureau of Economic Geology, University of Texas, Report of Investigations 88, 169 p., 9 pls.

Bell, W. C., and Ellinwood, H. L., 1962, Upper Franconian and lower Trempealeauan Cambrian trilobites and brachipods, Wilberns Formation, central Texas: Journal of Paleontology, v. 36, no. 3, p. 385-423.

Bick, K. F., 1966, Geology of the Deep Creek Mountains, Tooele and Juab Counties, Utah: Utah Geological and Mineralogical Survey Bulletin 77, 120 p.

Campbell, J. A., 1976, Upper Cambrian stromatolitic biostrome, Clinetop Member of the Dotsero Formation, western Colorado: Geological Society of America Bulletin, v. 87, p. 1331-1335.

Cohenour, R. E., 1959, Sheeprock Mountains, Tooele and Juab Counties, Utah: Utah Geological and Mineralogical Survey Bulletin 63, 201 p.

Derby, J. R., Lane, H. R., and Norford, B. S., 1972, Uppermost Cambrian-basal Ordovician faunal succession in Alberta and correlation with similar sequences in the western United States: International Geological Congress, 24th, Montreal, Proceedings, Section 7, p. 503-512.

Drewes, Harald, and Palmer, A. R., 1957, Cambrian rocks of southern Snake Range, Nevada: American Association of Petroleum Geologists Bulletin, v. 41, no. 1, p. 104-120.

Ethington, R. L., and Clark, D. L., 1971, Lower Ordovician conodonts in North America, *in* Conodont biostratigraphy: Geological Society of America Memoir 127, p. 63-82.

Hanks, K. L., 1962, Geology of the central House Range, Millard County, Utah: Brigham Young University Geology Studies, v. 9, pt. 2, p. 115-136.

Hintze, L. F., 1951, Lower Ordovician detailed stratigraphic sections for western Utah: Utah Geological and Mineralogical Survey Bulletin 39, 99 p.

_____1952 [1953], Lower Ordovician trilobites from western Utah and eastern Nevada: Utah Geological and Mineralogical Survey Bulletin 48, 249 p.

_____1973a, Geologic History of Utah: Brigham Young University Geology Studies, v. 20, pt. 3, 181 p.

_____1973b, Lower and Middle Ordovician stratigraphic sections in the Ibex area, Millard County, Utah: Brigham Young University Geology Studies, v. 20, pt. 4, p. 3-36.

_____1974a [1975], Preliminary geologic map of the Notch Peak quadrangle, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-636.

_____1974b [1975], Preliminary geologic map of The Barn quadrangle, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-633.

_____1974c [1975], Preliminary geologic map of the Conger Mountain quadrangle, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-634.

_____1974d [1975], Preliminary geologic map of the Crystal Peak quadrangle, Millard County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-635.

_____1974e [1975], Preliminary geologic map of the Wah Wah Summit quadrangle, Millard and Beaver Counties, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-637.

_____1980a, Preliminary geologic map of the Fish Springs NW and Fish Springs SW quadrangles, Juab and Tooele Counties, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1148.

_____1980b, Preliminary geologic map of the Sand Pass NW quadrangle, Juab County, Utah: U.S. Geological Survey Miscellaneous Field Studies Map MF-1149.

_____1982, Ibexian Series (Lower Ordovician) type section, western Utah, U.S.A., p. 7-10. *In* Ross, R. J., Jr., and Bergström, S. M., eds., The Ordovician System in the United States: International Union of Geological Sciences Publication No. 12, Ottawa, Ontario, Canada.

Hintze, L. F., and Palmer, A. R., 1976, Upper Cambrian Orr Formation—Its subdivisions and correlatives in western Utah: U.S. Geological Survey Bulletin 1405-G, 25 p.

Hose, R. K., 1961, Physical characteristics of Upper Cambrian stromatolites in western Utah: U.S. Geological Survey Professional Paper 424-D, p. D245-D248.

Kellogg, H. E., 1963, Paleozoic stratigraphy of the southern Egan Range, Nevada: Geological Society of America Bulletin, v. 74, p. 685-708.

Koepnick, R. B., 1976, Depositional history of the Upper Dresbachian-Lower Franconian (Upper Cambrian) Pterocephaliid biomere from west-central Utah: Brigham Young University Geology Studies, v. 23, pt. 2, p. 123-138.

Landing, Ed, 1981 [1982], Conodont biostratigraphy and thermal color alteration indices of the upper St. Charles and lower Garden City Formations, Bear River Range, northern Utah and southeastern Idaho: U.S. Geological Survey Open-File Report 81-740, 29 p.

Landing, Ed, Taylor, M. E., and Erdtmann, B. D., 1978, Correlation of the Cambrian-Ordovician boundary between the Acado-Baltic and North American faunal provinces: Geology, v. 6, no. 2, p. 75-78.

Lochman, Christina, and Hu, C. H., 1959, A *Ptychaspis* faunule from the Bear River Range, southeastern Idaho: Journal of Paleontology, v. 33, p. 404-427.

Longacre, S. A., 1970, Trilobites of the Upper Cambrian Ptychaspid biomere, Wilberns Formation, central Texas: The Paleontological Society Memoir 4; Journal of Paleontology, v. 44, Supplement no. 1, 70 p.

Merriam, C. W., 1964, Cambrian rocks of the Pioche mining district, Nevada: U.S. Geological Survey Professional Paper 469, 59 p.

Miller, J. F., 1969, Conodont fauna of the Notch Peak Limestone (Cambro-Ordovician), House Range, Utah: Journal of Paleontology, v. 43, p. 413-439.

_____1976, Conodont biostratigraphy and international correlations across the Cambrian-Ordovician boundary: International Geological Congress, 25th, Sydney, Abstracts, v. 1, p. 274.

_____1978, Upper Cambrian and lowest Ordovician conodont faunas of the House Range, Utah, *in*, J. F. Miller, ed., Upper Cambrian to Middle Ordovician conodont faunas of western Utah: Southwest Missouri State University Geoscience Series 5, p. 1-33.

Miller, J. F., Taylor, M. E., Stitt, J. H., Ethington, R. L., Hintze, L. F., and Taylor, J. F., 1982, Potential Cambrian-Ordovician boundary stratotype sections in the western United States, p. 155-180, *in*, Bassett, M. G., and Dean, W. T., eds., The Cambrian-Ordovician Boundary; Sections, fossil distributions, and correlations: National Museum of Wales (Cardiff) Geological Series 3, 227 p.

Morris, H. T., and Lovering, T. S., 1961, Stratigraphy of the East Tintic Mountains, Utah: U.S. Geological Survey Professional Paper 361, 145 p.

Nolan, T. B., 1935, The Gold Hill mining district, Utah: U.S. Geological Survey Professional Paper 177, 172 p.

Norford, B. S., 1969, The Early Canadian (Tremadocian) trilobites *Clelandia* and *Jujuyaspis* from the southern Rocky Mountains of Canada: Geological Survey of Canada Bulletin 182, p. 1-15.

Palmer, A. R., 1971, The Cambrian of the Great Basin and adjacent areas, western United States, *in*, Holland, C. H., ed., Cambrian of the New World: London, Wiley Interscience, p. 1-78.

Powell, D. K., 1959, The geology of southern House Range, Millard County, Utah: Brigham Young University Research Studies, Geology Series, v. 6, no. 1, 49 p.

Ross, R. J., Jr., 1949, Stratigraphy and trilobite faunal zones of the Garden City Formation, northeastern Utah: American Journal of Science, v. 247, p. 472-491.

_____1951, Stratigraphy of the Garden City Formation in northeastern Utah, and its trilobite faunas: Yale University, Peabody Museum of Natural History Bulletin 6, 161 p.

Runnegar, Bruce, Pojeta, John, Jr., Taylor, M. E., and Collins, D. H., 1979, New species of the Cambrian and Ordovician chitons *Matthevia* and *Chelodes* from Wisconsin and Queensland; evidence for the early history of polyplacophoran mollusks: Journal of Paleontology, v. 53, no. 6, p. 1374-1394.

Staatz, M. H., and Carr, W. J., 1964, Geology and mineral deposits of the Thomas and Dugway Ranges, Juab and Tooele Counties, Utah: U.S. Geological Survey Professional Paper 415, 188 p.

Stitt, J. H., 1971, Late Cambrian and earliest Ordovician trilobites, Timbered Hills and lower Arbuckle Groups, western Arbuckle Mountains, Murray County, Oklahoma: Oklahoma Geological Survey Bulletin 110, 83 p., 12 pls.

_____1977, Late Cambrian and earliest Ordovician trilobites, Wichita Mountains area, Oklahoma: Oklahoma Geological Survey Bulletin 124, 79 p., 7 pls.

_____1983, Trilobites, biostratigraphy, and lithostratigraphy of the McKenzie Hill Limestone (Lower Ordovician), Wichita and Arbuckle Mountains, Oklahoma: Oklahoma Geological Survey Bulletin 134, 54 p. 7 pls.

Taylor, M. E., 1971, Biostratigraphy of the Upper Cambrian (Upper Franconian-Trempealeauan Stages) in the central Great Basin, Nevada and Utah: University of California, Berkeley, Ph.D. thesis, 427 p.

Taylor, M. E., and Cook, H. E., 1976, Continental shelf and slope facies in the Upper Cambrian and Lowest Ordovician of Nevada, *in*, Robison, R. A., and Rowell, R. J., eds., Paleontology and depositional environments; Cambrian of western North America: Brigham Young University Geology Studies, v. 23, pt. 2, p. 181-214.

Taylor, M. E., and Glanzman, R. K., 1979, Implications of evaporites in the Upper Cambrian-Lower Ordovician Notch Peak Formation, southern House Range, western Utah: U.S. Geological Survey Open-file Report 79-1428, 12 p.

Taylor, M. E., and Halley, R. B., 1974, Systematics, environment, and biogeography of some Late Cambrian and Early Ordovician trilobites from eastern New York State: U.S. Geological Survey Professional Paper 834, 38 p.

Taylor, M. E., and Landing, Ed, 1982, Biostratigraphy of the Cambrian-Ordovician transition in the Bear River Range, Utah and Idaho, western United States, p. 181-191, *in* Bassett, M. G., and Dean, W. T., eds., The Cambrian-Ordovician boundary; Sections, fossil distributions, and correlations: National Museum of Wales (Cardiff) Geological Series 3, 227 p.

Taylor, M. E., and Miller, J. F., 1981, Upper Cambrian and Lower Ordovician stratigraphy and biostratigraphy, southern House Range, Utah, *in* Taylor, M. E., and Palmer, A. R., eds., Cambrian stratigraphy and paleontology of the Great Basin and vicinity, western United States: Second International Symposium on the Cambrian System, Guidebook for Field Trip 1; Denver, Colorado, p. 103-119.

Taylor, M. E., and Repetski, J. E., 1985, Early Ordovician eustatic sea-level changes in northern Utah and southeastern Idaho, *in* Kerns, G. J., Kerns, R. L., Jr., eds., Orogenic patterns and stratigraphy of north-central Utah and southeastern Idaho: Utah Geological Association Publication 14, p. 237-248.

Walcott, C. D., 1908a, Nomenclature of some Cambrian Cordilleran formations: Smithsonian Miscellaneous Collections, v. 53, no. 1, p. 1-12.

_____1908b, Cambrian sections of the Cordilleran area: Smithsonian Miscellaneous Collections, v. 53, no. 4, p. 167-230.

Whitebread, D. H., 1969, Geologic map of the Wheeler Peak and Garrison quadrangles, Nevada and Utah: U.S. Geological Survey Miscellaneous Geological Investigations Map I-578, 7 p.

Winston, Don, and Nicholls, Harry, 1967, Late Cambrian and Early Ordovician faunas from the Wilberns Formation of central Texas: Journal of Paleontology, v. 41, no. 1, p. 66-96.

Yochelson, E. L., 1966, Mattheva—A proposed new class of mollusks: U.S. Geological Survey Professional Paper 523-B, 13 p.

Yochelson, E. L., and Taylor, M. E., 1974, Late Cambrian *Matthevia* (Mollusca, Matthevida) in North America: Geological Society of America Abstracts with Programs, v. 6, no. 1, p. 88.

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