Field Guide to the Pioneer Mountains Core Complex, South-Central Idaho

Stephen L. Wust[1]
Paul Karl Link[2]

INTRODUCTION

The Pioneer Mountains (Fig. 1) east of Ketchum, Idaho contain a lower plate or core of gneiss, plutonic rocks, and complexly folded metasedimentary strata, and an upper plate composed of a stack of thrust sheets of unmetamorphosed Paleozoic strata overlain by Eocene volcanic and sedimentary rocks.

The area was mapped geologically by Dover (1969, 1981, 1983) who interpreted all low angle faults as thrusts. Current workers reinterpret the geologic relationships (Fig. 2) and suggest that the Pioneer Mountains are an extensional core complex, having evidence of both Mesozoic synkinematic plutonism and Paleogene extensional movement along the Wildhorse detachment system which separates the upper and lower plates (Wust, 1986a; 1986b; 1986c; O'Neal, 1985; Silverberg, 1986; Kim, 1986; Pavlis and O'Neill, 1985; 1987).

The rocks of the Pioneers can be divided into a lower plate (core) and an upper plate, separated everywhere by faults. Precambrian X gneisses, calc-silicates, and marbles are exposed in the central part of the core and are dated at 2 Ga (Dover, 1983). The southwest side of the core exposes a metasedimentary sequence, which includes calc-silicates, metaquartzites, and pelitic schists presumed by Dover (1981, 1983) to be Precambrian Y in age and unconformably overlain by Ordovician quartzites and marbles.

[1] *Chevron USA, Inc., P. O. Box 6056, New Orleans, LA 70174*

[2] *Department of Geology, Idaho State University, Pocatello, Id 83209*

The metamorphic core units are intruded by a Cretaceous-Tertiary granodiorite which is now deformed, a locally deformed quartz monzonite of probable Eocene age, and several minor intrusive bodies, also of probable Eocene age. Geochronologic studies of these plutons and core rocks are in progress by D. Silverberg, K. Hodges and J. Sutter.

Upper-plate units are mostly unmetamorphosed. Paleozoic strata are equivalents of the Antler orogenic belt sequences seen in Nevada. They include: (1) Ordovician, Silurian, and Devonian argillite, siltstone, and chert, with minor sandstone, dolomite, cherty dolomite, and limestone; this is the Antler "oceanic assemblage", of similar lithology to the upper plate of the Roberts Mountain overthrust; (2) the Milligen Formation, a Devonian siliceous argillite that is also part of the Antler overthrust assemblage; (3) the Copper Basin Formation, composed of Mississippian sandstone, conglomerate, siltstone, argillite, and limestone; this formation is part of the Antler flysch; and (4) the Wood River Formation, a Pennsylvanian to Permian unit of calcareous siltstone, calcareous sandstone, and limestone, with a basal chert-pebble conglomerate; this formation represents the Antler overlap sequence.

Overlying the Paleozoic strata are Eocene sedimentary and volcanic rocks. The basal sedimentary unit is only locally present and includes red sandstone and conglomerate; the conglomerate contains clasts of all

Wust, S. L., and Link, P. K., 1988, Field guide to the Pioneer Mountains core complex, south-central Idaho, *in* Link, P. K., and Hackett, W. R., editors, Guidebook to the Geology of Central and Southern Idaho: Idaho Geological Survey Bulletin 27, p. 43-54.

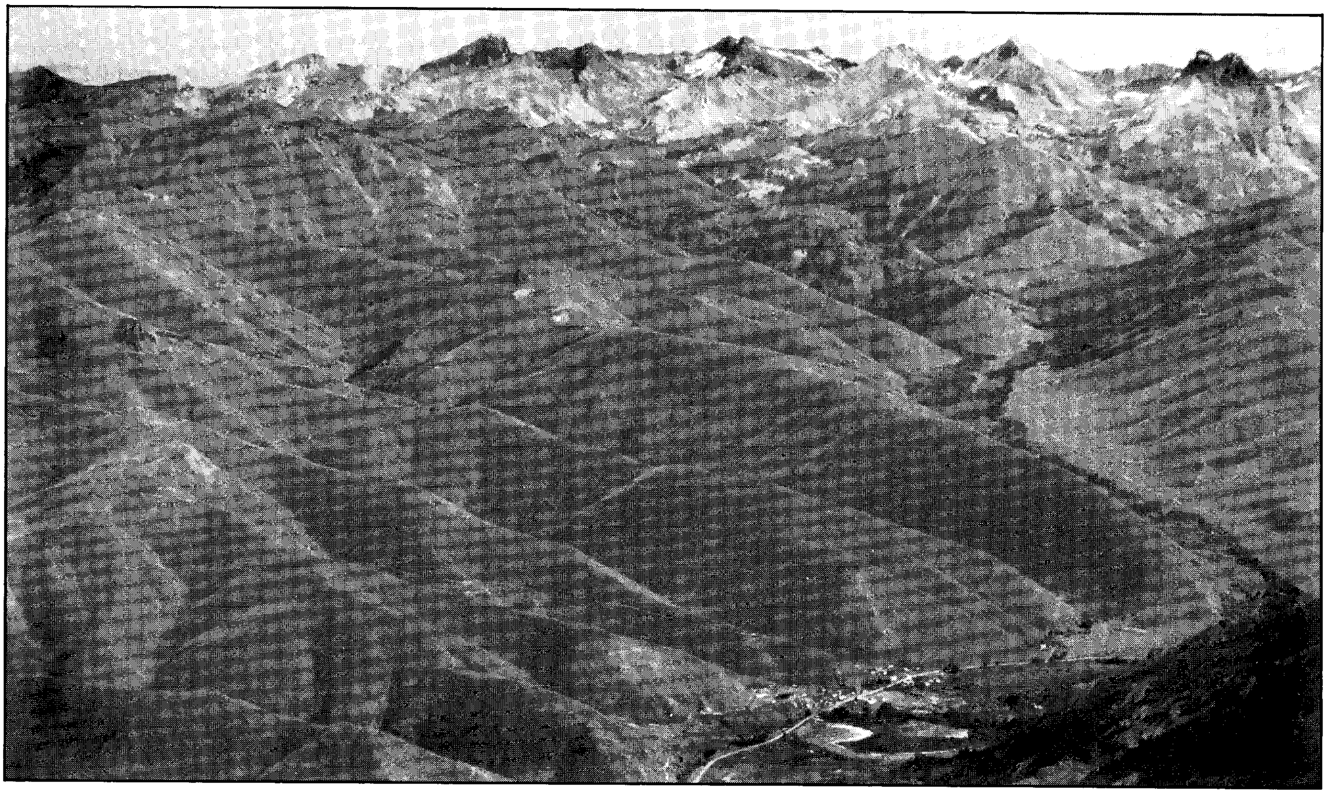

Figure 1. Aerial view looking east at the Pioneer Mountains and the valley of the East Fork of the Wood River. The Wildhorse detachment system separates the metamorphic and intrusive complex of the high peaks (lower plate or core) from unmetamorphosed strata of the upper plate. The town of Triumph and tailings pond from the Triumph silver-lead-zinc mine can be seen in the foreground.

upper-plate Paleozoic units. Challis Volcanics overlie the conglomerate and all upper-plate units, but they are not present in the core. The volcanic rocks are mostly andesitic to rhyolitic and in the vicinity of the Pioneer Mountains have radiometric ages of 38-42 Ma (Armstrong, 1975). Northwest of the core, the Summit Creek stock is intruded into upper-plate rocks. It is similar in petrography to the Eocene quartz monzonite in the core.

In the lower plate of the Pioneer Mountains core complex, Mesozoic deformation of the Sevier orogeny is manifested in the folding and metamorphism of Precambrian and Ordovician strata (Silverberg, 1986) and by the intrusion of the Cretaceous-Tertiary granodiorite pluton. Mesozoic deformation in the upper plate is represented by folding and thrusting of Paleozoic strata. Vergence of thrusts and overturned folds is consistently between northeast and east.

As defined by Wust (1986 a and b), the Wildhorse detachment system separates upper plate from lower plate rocks and includes the Wildhorse thrust and part of the Pioneer thrust system of Dover (1983). Trends of striations on the smooth slickensided surface of the detachment consistently cluster around N. 65°W. Mylonitic gneiss, marble, and quartzite are exposed on the northwest side of the core (lower plate), suggesting that the deepest levels of exposure are on the northwest and that during fault movement the upper plate moved northwest relative to the lower plate. Sense of shear derived from S-C relations in mylonites (Berthé and others, 1979) also gives a top-to-the-northwest sense of movement. Separation on the Wildhorse detachment system is estimated to be at least 17 km, based on two observations: a correlation of the quartz monzonite in the core with the Summit Creek stock of the upper plate, and on the width of exposure of lower plate rocks in the core of the range (Wust, 1986a).

The Wildhorse detachment system is interpreted to have formed during Paleogene extensional faulting associated with the development of the Pioneer Mountains core complex. Paleogene crustal extension in central Idaho is manifested not only by deformation in the Pioneer Mountains but also by the widespread and prolonged (51 to 40 Ma) Challis magmatic episode (McIntyre and others, 1982; Fisher and others, 1983; Moye and others, 1988, this volume) and by extension associated with the trans-Challis fault system (Bennett, 1986).

Areas north and west of the Pioneer Mountains also underwent Paleogene extension. Normal faults with shallow dips were mapped by W. E. Hall at several locations in the Wood River Valley to the west, and they

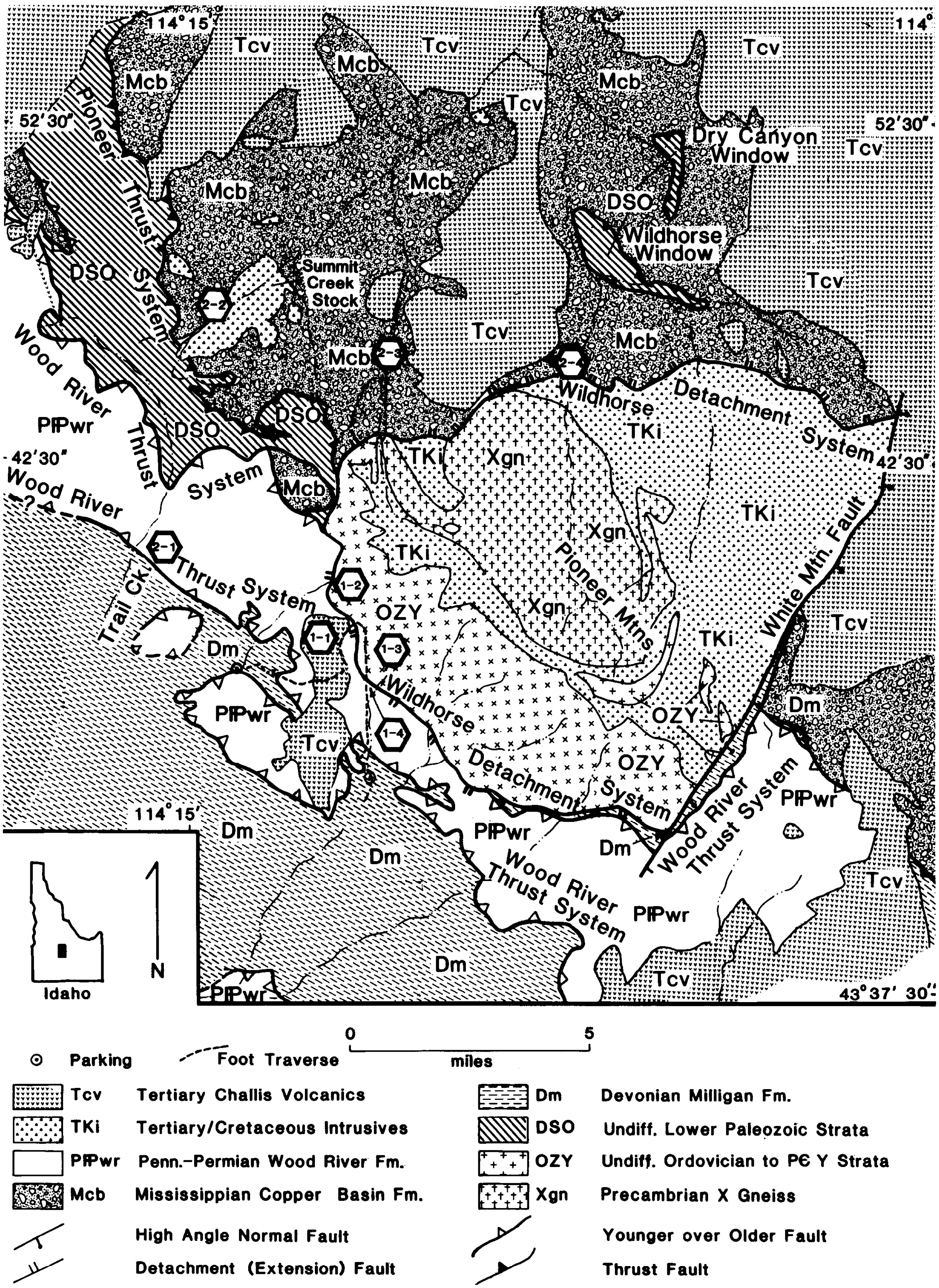

Figure 2. Regional geologic map of the Pioneer Mountains showing field trip stop locations. After Dover (1983) and Wust (1986a).

are also present in the Smoky and Boulder Mountains (Skipp and others, 1986; Otto and Turner, 1987; Ratchford, 1988; Link and others, 1987; 1988). Synchroneity of extensional faulting and the Challis magmatic episode is suggested by relations in the Baker Peak quadrangle of the Smoky Mountains where the Norton Lakes pluton, of similar composition to the Summit Creek stock, intrudes a low angle normal fault (Stewart, 1987; Mahoney, 1987).

The relationship of the plutons in the core to Mesozoic and Paleogene deformation of the Pioneer Mountains is important and controversial. Both plutons are cut by the Wildhorse detachment system. Although there was definitely post-intrusion movement along the Wildhorse detachment system, it is not known whether any of the movement was syn-intrusive. See the comment by Pavlis and O'Neill (1987) and the reply by Wust (1987) for discussion of both pluton geochronology and the timing of movement along the Wildhorse detachment system.

Another controversy concerns the timing of uplift of lower plate rocks. Dover (1981) used two lines of evidence to infer that the core of the Pioneers was uplifted before deposition of the Challis Volcanics. First is a landslide deposit near Pioneer Cabin (Stop 1-1) mapped as unconformably overlain by Challis Volcanics breccia, and containing Ordovician Kinnikinic Quartzite derived from the core. Second is the local conglomerate which underlies the Challis Volcanics and which was interpreted to contain clasts of Kinnikinic Quartzite.

However, uplift of the core before deposition of the Challis Volcanics is difficult to reconcile with recent conclusions that movement on the Wildhorse detachment system occured in Paleogene time, coeval with eruption of the Challis Volcanics. The geologic relations of the landslide are ambiguous (see discussion in field trip guide), and there are no Challis Volcanics in depositional contact with lower plate rocks. Lower plate clast provenance for the pre-Challis conglomerate is also questionable as Wust (1986a) could find no definitive lower plate clasts and interpreted the quartzites to have come from the upper plate Mississippian Copper Basin Formation.

FIELD TRIP GUIDE

The Pioneer Mountains are both a scenic alpine mountain range and a very well-exposed metamorphic core complex. This guide describes two days of geologic field trips in the Pioneers. Figure 1 shows the general geology and stop locations. The field trips require day-long hikes into the foothills of the Pioneers, up to 9500 feet elevation. Food, water, and appropriate clothing and footwear for high mountain travel are essential. Those using this field guide will find the geologic map of Dover (1983) essential, and the Hyndman Peak and Phi Kappa Mountain 7.5-minute topographic quadrangles very helpful.

The field trips address the stratigraphy of upper plate strata along the Pioneer Cabin trail and the Trail Creek road, the Wildhorse detachment system below Pioneer Cabin, the nature of the core rocks east of Pioneer Cabin at Kane Creek and at Wildhorse campground, and the progressive increase in deformation of the core as the detachment is approached at Kane Creek.

Day 1: Geology of Corral and North Fork Hyndman Creeks near Pioneer Cabin.

This field trip involves a foot traverse of approximately 8 miles and 3000-foot elevation gain from Corral Creek to the North Fork of Hyndman Creek. The one-way traverse requires that a vehicle be spotted at North Fork Hyndman Creek.

The Corral Creek parking area is reached by driving northeast on the Sun Valley-Trail Creek Road from the stoplight in downtown Ketchum. Proceed for 4.9 miles and turn right on the Corral Creek road. Proceed 3.8 miles to parking area at the end of the road.

In the valley of the Big Wood River, Trail Creek, and Corral Creek, the Wood River Formation everywhere overlies dark argillites, limestones, and siltstones of the Milligen Formation along a system of younger-over-older faults that are designated the Wood River thrust (Hall and others, 1978; Dover, 1983). Details of stratigraphy and deformation of the Milligen Formation are discussed by Turner and Otto (1988, this volume). The field trip by Link and others (1988, this volume) discusses strata of the Wood River Formation and relations along the Wood River thrust system.

The Wood River Formation contains at least 3000 meters of strata divided into seven units (Hall and others, 1974). The base of the Wood River Formation is the Hailey Conglomerate which contains quartzite and argillite clasts, some of which were derived from the underlying Milligen Formation. The bulk of the overlying units of the Wood River Formation are sandy limestone, calcareous sandstone, quartzite, and dark mudstone.

In many places in the Wood River Valley, upper units of the Wood River Formation are faulted on Milligen Formation, and synclines in Wood River Formation are truncated along a shallowly dipping fault above the Milligen Formation, suggesting that parts of the Wood River thrust system were reactivated as low angle normal faults (Skipp and others, 1986; Link and others, 1988, this volume).

Geology along the Pioneer Cabin Trail above Corral Creek

The lower slopes of the trail are in Milligen Formation. At 7800 feet elevation the trail crosses the Wood River thrust into Wood River Formation. At the top of the switchbacks (7900 feet) are outcrops of brownweathering calcareous quartzite of Wood River Formation unit 6.

Problematic Landslide Deposit

Where the trail leaves the trees at elevation 8600 feet, it crosses onto what is mapped by Dover (1983) as a landslide deposit, of Tertiary or Cretaceous age, and composed of blocks of brecciated Ordovician Kinnikinic Quartzite derived from the lower plate of the Wildhorse detachment system. As mapped, the landslide is overlain by heterolithologic epiclastic breccia of the Challis Volcanics. This implies that the core was elevated during Sevier thrusting or Cretaceous intrusion and is contrary to the idea that uplift of the core occurred during movement on the Wildhorse detachment system. Problems with the mapped relation include the absence of Challis rocks within the core, and the absence within the landslide of core rocks other than quartzite.

An alternate interpretation of the outcrop geometry is that the landslide overlies and surrounds the Challis Volcanics. Problems with this interpretation include the absence of volcanic clasts within the landslide and the lack of clear evidence for superposition.

The simplest explanation may be that the landslide is composed of brecciated and silicified quartzites of the Wood River Formation of the upper plate rather than Kinnikinic Quartzite (R. Turner, pers. comm., 1987), and that it is overlain by Challis Volcanics breccia. This would imply uplift of upper plate strata, but not exposure of lower plate rocks, prior to Challis volcanism.

Critical unanswered questions concerning the mapped landslide are whether it contains Kinnikinic Quartzite or quartzite of the Wood River Formation, and the stratigraphic relationships between the landslide deposits and the Challis Volcanics.

Proceed over the landslide deposit and up the hill. At the trail junction with the Johnstone Creek trail take the left fork to Pioneer Cabin. At the junction the view to the southwest is of Johnstone Peak, which is underlain by folded upper Wood River Formation and Devonian Milligen Formation in the lower slopes. The contact is a steeply dipping fault, mapped by Dover (1983) as the folded Wood River thrust. The ridge north of Johnstone Peak is underlain by Challis Volcanics. The orange talus-strewn hill half a mile to the northwest is composed of brecciated quartzite of the landslide.

The trail crosses heterolithologic breccia of the Challis Volcanics, then back into brecciated quartzite, and up a talus slope before cresting the ridge at Pioneer Cabin (elevation 9440 feet).

Stop 1-1: Panorama at Pioneer Cabin

Pioneer Cabin (Fig. 3) was built in the 1930s for a ski touring basecamp during early development of Sun Valley resort. The view from the outhouse is magnificent.

The cabin is a good spot to get an overview of the Pioneer Mountains. The view to the northeast is of the Hyndman Creek drainage. The high peaks (from north to south: Handwerk, Hyndman, and Cobb) are underlain by middle Proterozoic metasedimentary rocks intruded by dikes and stocks of both the Cretaceous-Tertiary granodiorite pluton and unfoliated Eocene quartz monzonites (Summit Creek stock lithology) (Dover, 1983). Folded Ordovician strata are starkly exposed in the floor of the valley (Stop 1-3). Precambrian X gneisses crop out in the core, east and behind the high peaks, but are not visible from here. The Wildhorse detachment is exposed at the north end of the ridge on which the Pioneer Cabin is located. There it dips southward, but it flattens under the cabin and steepens again to intersect North Fork Hyndman Creek less than a mile to the south near Stop 1-4.

To the south and west lies the upper plate of the Wildhorse detachment. The hills near the cabin are not well exposed, and have been mapped as the landslide deposit. In the vicinity of the cabin the landslide is mapped as overlying quartzite of Wood River Formation unit 5.

Proceed northward along the ridge (Fig. 4) for one-half mile to the Wildhorse detachment fault.

Stop 1-2: Wildhorse detachment North of Pioneer Cabin

The Wildhorse detachment can be examined where the ridge north of Pioneer Cabin steepens abruptly (9200 feet, south border of the Phi Kappa Mountain quad). Here the detachment dips about 50 degrees to the south. Upper plate rocks are Wood River Formation sandstones, limestones and quartzites. Foliated calc-silicate Ella Marble makes up the lower plate. A prominent cleavage is present at about 30 degrees to the dominant foliation, which parallels the detachment. The undulating trace of the detachment is obvious to the south toward Stop 1-4.

Proceed down and to the east into the lower plate toward conspicuous folded quartzite and marble exposures in the head of the valley of North Fork Hyndman Creek.

Stop 1-3: Folded Ordovician Strata

Metasedimentary beds at 8400-8600 feet elevation in the floor of the glaciated valley of North Fork Hyndman Creek (Fig. 5) are all of Ordovician age and are, in ascending stratigraphic order: Ella Marble, Kinnikinic Quartzite, and sandy tremolite-bearing marble of the Saturday Mountain Formation. Each lithology behaved differently during Mesozoic(?) folding, resulting in the complex interfingering of folded Ella Marble and Kinnikinic Quartzite in the floor of the cirque.

Proceed south down the creek. A trail on the west side of the creek can be joined in the trees about one-half mile to the south, directly below Pioneer Cabin. The trail crosses poorly exposed lower plate rocks. An overhanging cliff of Kinnikinic Quartzite lies west of the

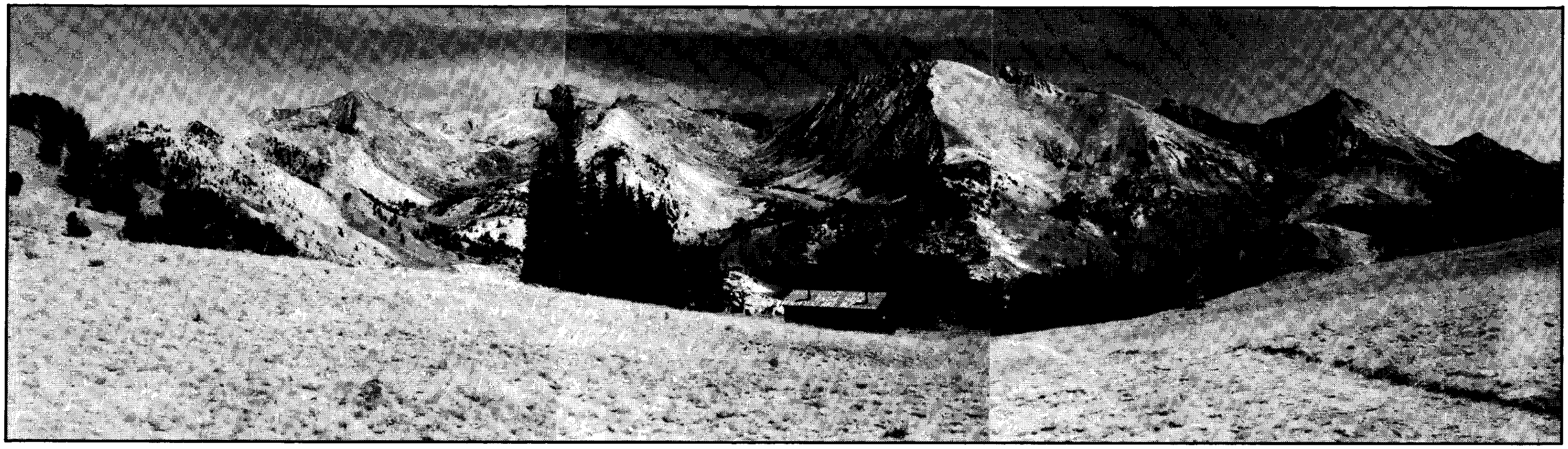

Figure 3. Panorama from Pioneer Cabin (Stop 1-1). The peaks on the skyline make up the cirque of the North Fork of Hyndman Creek, and are underlain by Proterozoic and Ordovician metasedimentary rocks intruded by a Tertiary-Cretaceous granodiorite pluton which makes up the prominent, jointed face directly over the roof of the cabin. The cabin lies on the upper plate of the Wildhorse detachment. The detachment is located just behind the trees on the left side of the view.

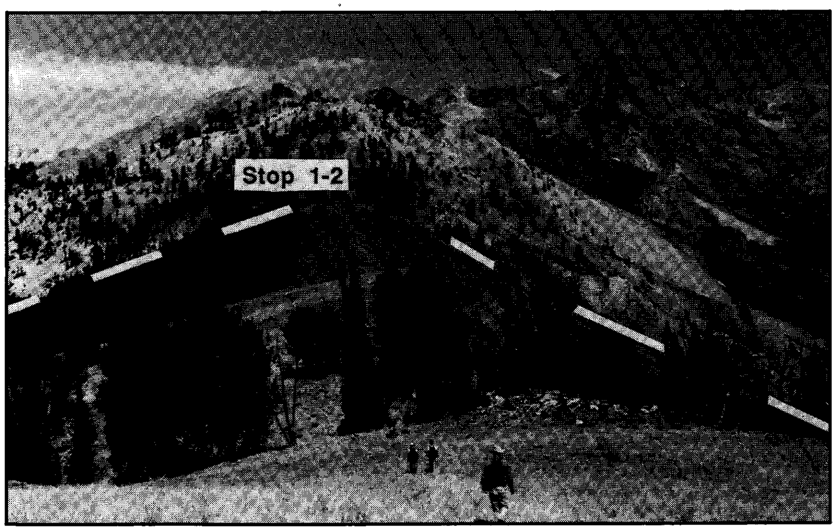

Figure 4. View to the north along ridge north of Pioneer Cabin. Location of Stop 1-2 and the trace of the Wildhorse detachment are shown. White outcrops in the lower plate are Ordovician metasedimentary rocks. The peak on the skyline is underlain by Tertiary-Cretaceous granodiorite.

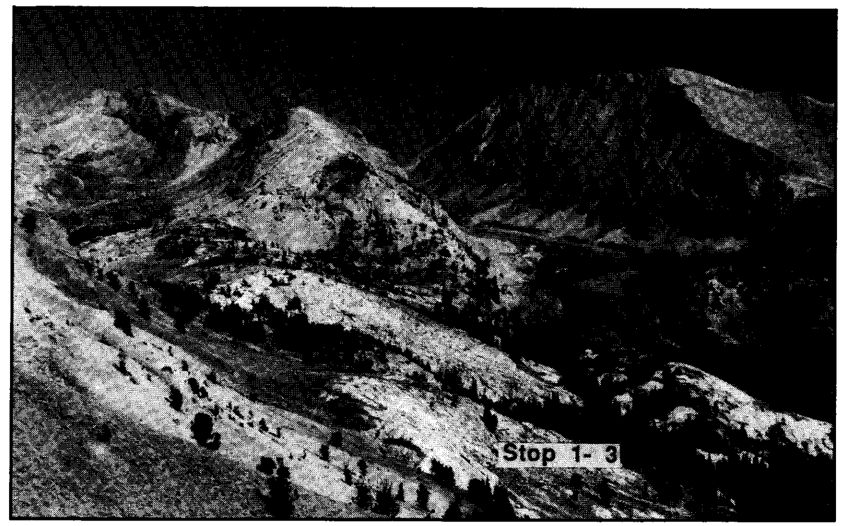

Figure 5. Cirque of North Fork, Hyndman Creek and location of Stop 1-3. White outcrops in the floor of the valley are Ordovician Kinnikinic Quartzite, grassy areas in the valley floor are Ordovician Ella Marble and Saturday Mountain Formation.

trail about a mile from Stop 1-3. The Wildhorse detachment is immediately above the overhanging cliff.

Stop 1-4: Wildhorse detachment Below Pioneer Cabin

A spectacular exposure of the Wildhorse detachment (Figs. 6 and 7) can be reached by climbing about 700 feet up a steep talus slope that intersects the trail from the west at elevation 7700 feet. This is the first talus of Wood River Formation limestones.

The detachment is exposed at elevation 8400 feet on the north side of the talus, where it is a polished and striated undulating surface on Ordovician Kinnikinic Quartzite of the lower plate. Lineations on the surface consistently trend to the northwest, but the dip of the surface varies from horizontal to 70 degrees south. Upper plate rocks consist of chaotic and brecciated Wood River limestones and calcareous sandstones which are exposed on the southwest side of the talus slope.

In contrast to areas to the north (e.g., Kane Creek--Stop 2-3), the detachment here contains no mylonite. The Kinnikinic is an unmylonitized quartz arenite. Brittle deformation is demonstrated by local areas of quartzite breccia along the detachment and subsidiary faults in the Kinnikinic Quartzite below the detachment.

Return down the talus slope and continue down the trail. West of the trail, Wood River Formation including the basal Hailey Conglomerate crops out. Where Button Creek enters from the west (about one mile from Stop 1-4) a buttress of Challis Volcanics can be seen to the west. The parking area is a little over two miles from Stop 1-4.

Drive down the Hyndman Creek road, turn right at mile 1.7, turn right again on the East Fork Wood River Road (mile 4.9), pass tailings of the Triumph silver-lead-zinc mine in argillite of the Devonian Milligen Formation (mile 6.6), and turn right on Highway 75 at mile 11.9. The lower reaches of the East Fork drainage are bounded by steep sage-covered hills underlain by Devonian Milligen Formation on the north and Pennsylvanian-Permian Wood River Formation on the south (Hall and others, 1978; Batchelder and Hall, 1978; Hall, 1985).

The Ketchum stoplight is 5.6 miles to the north of the East Fork Road.

Day 2: Field Trip up Trail Creek to Kane and Wildhorse Canyons

From the stoplight in Ketchum, proceed northeast on Sun Valley Road. The road follows the valley of Trail Creek through the stack of allochthons on the west flank of the Pioneer and Boulder Mountains (Fig. 1). The upper allochthons above the Wood River thrust system contain Pennsylvanian-Permian Wood River Formation. Devonian Milligen Formation lies under the Wood River thrust and is exposed south of Wilson Creek.

Figure 6. Curved and grooved surface of the Wildhorse detachment on Ordovician Kinnikinic Quartzite at Stop 1-4. View is to the south; hammer handle trends N.65°W.; head is on northwest side.

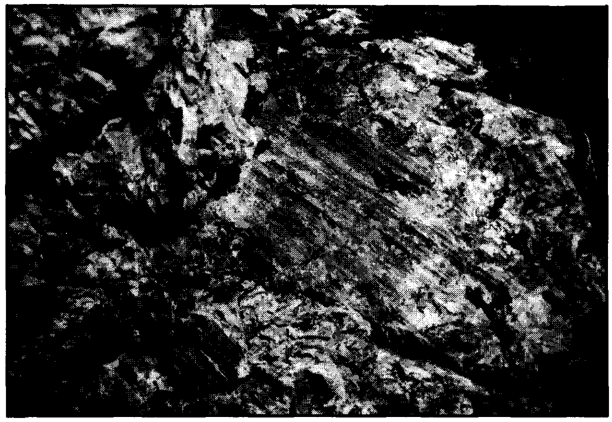

Figure 7. Surface of the Wildhorse detachment at Stop 1-4. Slickensides on lower plate Ordovician Kinnikinic Quartzite trend N.65°W. Brecciated limestone of the Pennsylvanian-Permian Wood River Formation makes up the upper plate.

The Wood River Formation is complexly folded and imbricated between Wilson Creek and the upper part of the canyon.

Stop 2-1: Wood River Thrust on Trail Creek Road

Pull out at wide part of the road 8.2 miles from the stoplight in downtown Ketchum. Just down hill from the inside bend in the road, the Wood River thrust system is unusually well exposed. The thrust separates calcareous sandstone of the upper part of the Wood River Formation from argillites and dark graptolitic shales of the Ordovician and Silurian Phi Kappa Formation, Silurian Trail Creek Formation, and other strata of the western facies oceanic assemblage. The plate of oceanic assemblage rocks is bounded above by the Wood River thrust and below by the Pioneer thrust and Mississipian Copper Basin Formation.

Return to the cars and continue up Trail Creek. The road remains in the oceanic assemblage over Trail Creek Summit and to Park Creek (13.0 miles), where it enters the lower allochthons which consist of Mississippian Copper Basin Formation, a thick and folded sequence of carbonaceous mudstones, quartzose flysch, turbidite fan channel conglomerates, and thin limestone marker beds. The Copper Basin Formation is duplicated along the Glide Mountain thrust (Dover, 1983).

Stop 2-2: Little Fall Creek View

This stop is located at mile 13.9 where the road crosses Little Fall Creek. To the north (Fig. 8) are rocks of the Copper Basin allochthon which is overlain at the top of the mountain by the oceanic assemblage along the Pioneer thrust, and intruded by the Eocene Summit Creek stock. A rough 4-wheel drive road up Little Fall Creek affords access to the thrust, which is a smooth surface on silicified Copper Basin Formation and is overlain by tightly folded black argillite of the oceanic plate.

Return to vehicles and proceed north heading down the Summit Creek drainage. The Summit Creek stock crops out on the south side of the road east of Park Creek, and on both sides of the road at mile 14.5 between Little and Big Fall Creeks.

Pass the road to Phi Kappa Creek at mile 16.1 and turn south on Kane Creek Road just after crossing Summit Creek at mile 19.1. Proceed 4.8 miles up the primitive Kane Creek Road. Hills on both sides of the road are Copper Basin Formation. The bare cliffs at the head of the valley are lower plate rocks of the core.

Figure 8. View at Stop 2-2 of Little Fall Creek. Dark rocks on the skyline are Ordovician to Devonian argillites, siltites, and cherts of the "oceanic assemblage" which overlie the Pioneer thrust. The cliff in the middle distance is Mississippian Copper Basin Formation below the thrust. Light-colored dikes of Eocene granodiorite (Summit Creek stock) intrude both plates.

Stop 2-3: Wildhorse detachment in Kane Creek

Mylonitic lower plate rocks and the Wildhorse detachment are exposed between the forks of Kane Creek about 1 mile north of the Devils Bedstead (Phi Kappa Mountain Quadrangle). Park the cars at the fourth crossing of Kane Creek (4.8 miles from the main Trail Creek-Summit Creek road) and follow the trail along the west side of Kane Creek for about half a mile to a footbridge. Cross to east side of creek and follow jeep road until it cuts sharply to the left. Continue straight along the trail that follows the creek. Cross the main fork of Kane Creek at elevation 7900 and proceed up the cliff and talus west of the creek (first prominent bare exposures). The detachment is located in the prominent saddle at the base of the cliff on the ridge to the west at 8950 feet elevation.

This locality exposes a cross section of deformed rocks of the lower plate in what is thought to be the structurally deepest exposed level of the detachment system. Lower plate rocks include foliated Tertiary-Cretaceous granodiorite intimately mixed with Ordovician and Precambrian Y metasedimentary rocks and Precambrian X gneiss. The granodiorite has zones of well-developed foliation as well as unfoliated hornblende-rich zones. Several hundred meters below the detachment the rocks have no lineation but display complex foliation and several orientations of ductile folds formed during Mesozoic or earlier deformation. Farther up the hill, the foliation progressively becomes parallel with the detachment, and a N. 60°W. lineation becomes dominant. At elevation 8800 feet, sills of granodiorite with S-C mylonitic fabrics and interlayered mylonitic quartzite, marble, and granodiorite (Fig. 9) are exposed. Lineations and rotated porphyroblasts support movement to N. 60°W. along mylonitic foliation surfaces that parallel the detachment.

Figure 9. Foliated rocks about 30 meters below the Wildhorse detachment at Kane Creek, Stop 2-3. The thinly layered rock is foliated Ordovician Ella Marble, which is intruded by a granodiorite sill that has been subsequently deformed.

Upper plate black argillite, graded sandstone and conglomerate of the Mississippian Copper Basin Formation can be observed along the ridge to the north.

From the saddle area, the view to the east is of the Wildhorse detachment across Left Fork of Kane Creek (Fig. 10). The view to the southwest along the Right Fork of Kane Creek shows the Pioneer thrust system of Dover (1983) striking into the Wildhorse detachment (Fig. 11). The lithologic change along the western slopes delineates the thrust; the intersection of the two faults is hidden under Quaternary sediments along the creek. Contrary to Dover's interpretation, Wust maps the detachment as cutting the Pioneer thrust: note that the style and orientation of lower-plate structures stay consistent across the intersection of the two faults.

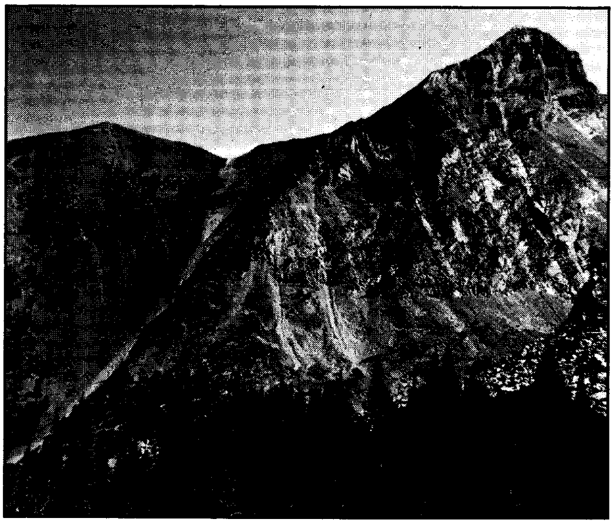

Figure 10. View to the east of the Wildhorse detachment from saddle between Left and Right Forks of Kane Creek (Stop 2-3). Cliff is made up of both the Cretaceous-Tertiary granodiorite and the Eocene granodiorite of the lower plate. Detachment is at prominent break in slope, and not in the saddle. Upper plate rocks are Mississippian Copper Basin Formation.

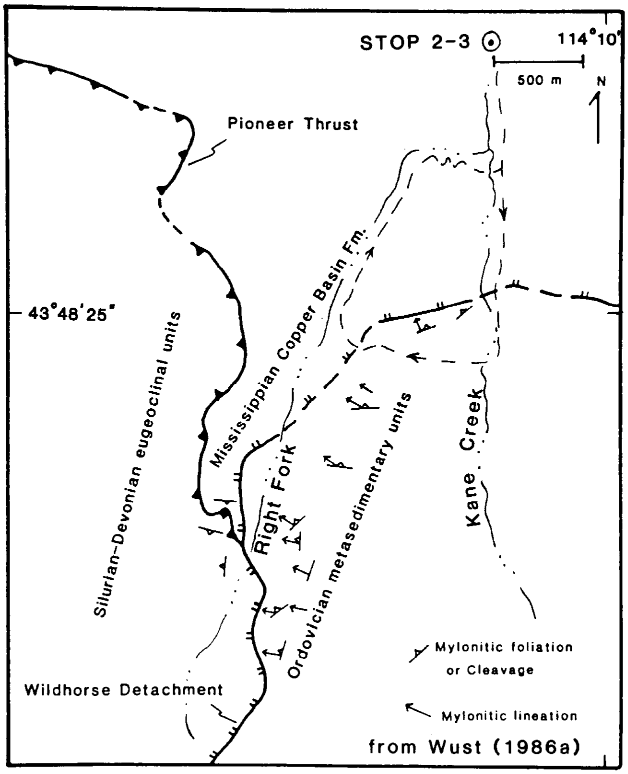

Figure 11. Geology of the junction between the Pioneer thrust and the Wildhorse detachment near Right Fork Kane Creek. From Wust (1986a, Fig. 7.)

Return to cars via trail along the Right Fork of Kane Creek. The trail can be reached by going directly downslope to the west almost to the valley floor. Walk on the trail to the north and east down switchbacks to the main fork and then downstream along the main trail to the cars. Return to the Summit Creek-Trail Creek road (4.8 miles).

The drive up Wildhorse Creek is scenic (Fig. 12) and affords a look at Precambrian X gneiss of the core. Proceed 3.2 miles northeast down the Trail Creek-Summit Creek Road and turn south on the Copper Basin-Wildhorse Road. Proceed 2.1 miles to the junction to Copper Basin. Take the right fork heading up Wildhorse Creek. The high bare peak visible in the core of the range is Old Hyndman Peak, which is underlain by Eocene quartz monzonite similar in composition to the Summit Creek stock. At 5.5 miles from the Summit Creek Road, just after crossing Wildhorse Creek, bear right toward Wildhorse Campground; the left fork goes to Fall Creek.

Stop 2-4: Wildhorse Campground: Core Rocks

The campground is located 7.8 miles from the Summit Creek-Trail Creek Road and is on the trace of the Wildhorse detachment, which follows Boulder Creek to the west. Up the primitive road past the campground, boulders are seen with varying lithologies of complexly deformed Precambrian X gneiss (Figs. 13 and 14) and foliated Eocene porphyritic quartz monzonite (Fig. 15) of the core. A climb is necessary to see the outcrop but all core lithologies are represented in the glacially polished boulders.

End of field trip.

ACKNOWLEDGMENTS

This manuscript is a revised version of Wust and Link (1987). Early versions of this field guide were reviewed by Charles Waag and David W. Rodgers.

Figure 12. View to the south of the cirque of Wildhorse Creek. Small peak on the right skyline is old Hyndman Peak. Prominent peak in left-center is unnamed and is underlain by early Proterozoic gneiss.

Figure 13. Thinly layered, kink-folded Proterozoic schist boulder from Wildhorse Creek. Note shear zones marked on photograph.

Figure 14. Banded Proterozoic gneiss boulder from Wildhorse Creek.

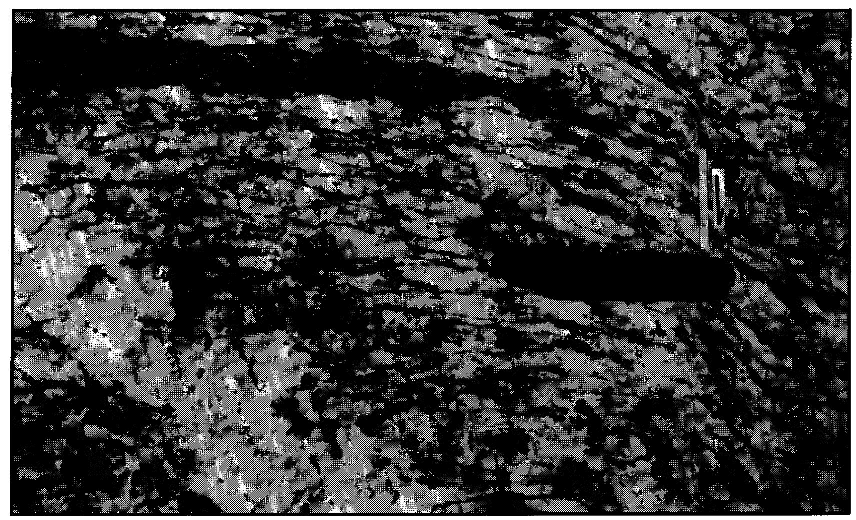

Figure 15. Orthogneiss boulder from Wildhorse Creek; rock is possibly the foliated Tertiary-Cretaceous pluton, with mafic inclusion at upper left. A shear zone is marked on photograph.

REFERENCES

Armstrong, R. L., 1975, The geochronometry of Idaho: Isochron/West, 50 p.

Batchelder, J. N., and Hall, W. E., 1978: Preliminary geologic map of the Hailey 7.5-minute quadrangle, Idaho, U. S. Geological Survey Open-File Report 78-545, scale 1:24,000.

Bennett, E. H., 1986, Relationship of the trans-Challis fault system in central Idaho to Eocene Basin and Range extensions: Geology, v. 14, p. 481-484.

Berthé, D., Choukroune, P., and Jegouzo, P., 1979, Orthogneiss, mylonite, and non-coaxial deformation of granites: the example of the South Armorican Shear Zone: Journal of Structural Geology, v. 1, p. 31-42.

Dover, J. H., 1969, Bedrock geology of the Pioneer Mountains, Blaine and Custer Counties, central Idaho: Idaho Bureau of Mines and Geology Pamphlet 142, 66 p.

_____, 1981, Geology of the Boulder-Pioneer Wilderness study area, Blaine and Custer Counties, Idaho: U. S. Geological Survey Bulletin 1497, p. 15-75.

_____, 1983, Geologic map and sections of the central Pioneer Mountains, Blaine and Custer Counties, central Idaho: U. S. Geological Survey Miscellaneous Investigations Series Map I-1319, scale 1:48,000.

Fisher, F. S., McIntyre, D. H., and Johnson, K. M., 1983, Geologic map of the Challis 1 x 2 degree quadrangle, Idaho: U. S. Geological Survey Open-File Report 83-523, 41 pp., 2 maps, scale 1:250,000.

Hall, W. E., 1985, Stratigraphy and mineral deposits in middle and upper Paleozoic rocks of the black-shale mineral belt, central Idaho, *in* McIntyre, D. H. editor, Symposium on the geology and mineral depo-sits of the Challis 1 x 2 degree quadrangle, Idaho: U. S. Geological Survey Bulletin 1658, Chapter J, p. 117-132.

Hall, W. E., Batchelder, J. N., and Douglass, R. C., 1974, Stratigraphic section of the Wood River Formation, Blaine County, Idaho: U. S. Geological Survey Journal of Research, v. 2, no. 1, p. 89-95.

Hall, W. E., Batchelder, J. N., and Tschanz, M., 1978, Preliminary geologic map of the Sun Valley 7.5-minute quadrangle, Idaho: U. S. Geological Survey Open-File Report 78-1056, scale 1:24,000.

Kim, A. Y. H., 1986, The kinematics of brittle polyphase deformation within the Pioneer Mountains core complex, Pioneer Mountains, Idaho: Masters thesis, Lehigh University, Bethlehem, Pennsylvania, 129 p.

Link, P. K., Mahoney, J. B., Burton, B. R., Ratchford, Edward, Turner, R. J. W., and Otto, B. R., 1987, Introduction to the geology of the central Idaho black shale mineral belt: Northwest Geology, v. 16, p. 61-84.

Link, P. K., Skipp, B. A., Hait, M. H., Jr., Janecke, Susanne, and Burton, B. R., 1988, Structural and stratigraphic transect of south-central Idaho: a field guide to the Lost River, White Knob, Pioneer, Boulder, and Smoky Mountains, *in* Link, P. K., and Hackett, W. R., editors, Guidebook to the geology of central and southern Idaho: Idaho Geological Survey Bulletin 27, p. 5-42.

McIntyre, D. H., Ekren, E. B., and Hardyman, R. F., 1982, Stratigraphic and structural framework of the Challis Volcanics in the eastern half of the Challis 1x2 degree quadrangle, *in* Bonnichsen, Bill, and Breckenridge, R. M., editors, Cenozoic geology of Idaho: Idaho Geological Survey Bulletin 26, p. 3-22.

Mahoney, J. B., 1987, Geology of the northern Smoky Mountains and stratigraphy of a portion of the Permian Grand Prize Formation, Blaine and Camas Counties, Idaho: Masters thesis, Idaho State University, Pocatello, Idaho.

Moye, F. J., Hackett, W. R., Blakley, J. D., and Snider, L. G., 1988, Regional geologic setting and volcanic stratigraphy of the Challis volcanic field, central Idaho, *in* Link, P. K., and Hackett, W. R., editors, Guide to the geology of central and southern Idaho: Idaho Geological Survey Bulletin 27, p. 87-97.

O'Neill, R. L., 1985, Superposition of Cenozoic extension on Mesozoic compressional structures in the Pioneer Mountains, central Idaho: Masters thesis, Lehigh University, Bethlehem, Pennsylvania, 59 pp.

Otto B. R., and Turner, R. J. W., 1987, Stratigraphy and structure of the Milligen Formation, Sun Valley area, Idaho: Northwest Geology, v. 16, p. 95-103.

Pavlis, T. L, and O'Neill, R. L., 1985, Superposition of Cenozoic extension on Mesozoic compressional structures of the Pioneer Mountains, central Idaho: Geological Society of America Abstracts with Programs, v. 17, p. 397-398.

_____ , 1987, Comment on "Extensional deformation with northwest vergence, Pioneer core complex, central Idaho": Geology, v. 15, p. 283-284.

Ratchford, M. E., 1988, Geology of the Boulder Basin, Blaine and Custer Counties, Idaho: Masters thesis, University of Idaho, Moscow, Idaho, (in prep.).

Silverberg, D. S., 1986, Metamorphic petrology and structure of the Hyndman and East Fork Formations of the Pioneer core complex, Idaho: Geological Society of America Abstracts with Programs, v. 18, no. 2, p. 185.

Skipp, Betty, Hall, W. E., and Link P. K., 1986, Pre-middle Eocene extension in south-central Idaho--the Wood River allochthon: Geological Society of America Abstracts with Programs, v. 18, no. 6, p. 753.

Stewart, D. E., 1987, Geology of the north half of the Baker Peak quadrangle, Blaine and Camas Counties, Idaho: Masters thesis, Idaho State University, Pocatello, Idaho, 113 pp.

Turner, R. J. W. and Otto, B.R., 1988, Stratigraphy and structure of the Milligen Formation, Sun Valley area, Idaho, *in* Link, P. K., and Hackett, W. R., editors, Guidebook to the geology of central and southern Idaho: Idaho Geological Survey Bulletin 27, p. 153-167.

Wust, S. L., 1986a, Tectonic development of the Pioneer structural complex, central Idaho: Ph. D. thesis, University of Arizona, Tucson, Arizona, 79 pp.

_____, 1986b, Extensional deformation with northwest vergence, Pioneer core complex, central Idaho: Geology, v. 14, p. 712-714.

_____, 1986c, Regional correlation of extension directions in Cordilleran metamorphic core complexes: Geology, v. 14, p. 828-830.

_____, 1987, Reply to comment on "Extensional deformation with northwest vergence, Pioneer core complex, central Idaho": Geology, v. 15, p. 284.

Wust S. L., and Link, P. K., 1988, Geology of the Pioneer Mountains core complex, south-central Idaho: Northwest Geology, v. 16, p. 85-94.