GEOTECHNICAL INVESTIGATION

ASSESSMENT OF ROCK SLOPE CONDITIONS ALONG KINGSBURY GRADE ROAD - SR 207 DOUGLAS COUNTY, NEVADA

MARCH 1996

NEVADA DOT
GEOTECHNICAL ENGINEERING

MATERIALS DIVISION

STATE OF NEVADA
DEPARTMENT OF TRANSPORTATION
MATERIALS DIVISION

MEMORANDUM

March 1, 1996

To: Steve Oxoby, Chief Road Design Engineer

From: Parviz Noori, Principal Geotechnical Engineer P.N.

Subject: Assessment of rock slope conditions along Kingsbury Grade Road, SR 207. E.A. 72028-9.

During the 1st week of August, 1995 the Geotechnical Section conducted a field evaluation of the condition of rock cuts and slopes which border SR 207. Prior to this Mark Salazar met with Mr. Dan Lopez, Highway Maintenance Supervisor I, Gardnerville Station, and did a preliminary drive through of the project limits. During this time Mr. Lopez pointed out areas which in his experience have caused his crew the most problems.

Slopes were roughly located in the field by using vehicle odometer measurements from field posted mile markers. When project alignment information (ie..cross sections and plan sheets) become available these locations should be converted to appropriate stationing. Field observations and design recommendations for each slope are listed below:

MP 0.85 - 0.90 (south side)
Slope scale (photo 1) loose boulders and rocks and clean catchment area. Consider removing granite nose (photo 2) to improve roadway drainage and help reduce water erosion of roadway. This granite outcrop is located about 15' downslope and across from Hall Court road.

MP 0.95 - 1.05 (south side)
Slope scale loose rocks and boulders (photo 3), remove dead trees which may fall onto roadway, and clean catchment area.

MP 1.05 - 1.1 (south side)
Slope scale loose rocks, clean and reshape catchment area, keep trees on slope intact (photo 4). Should address drainage erosion along south side of roadway (photo 5), suggest using asphalt paved ditch if Hydraulics agrees.

MP 1.15 to 1.2 (south side)
Slope scale loose rocks (photo 6). Clean, reshape, and pave catchment ditch. No work needed on small cut located on northside just east of Terrace View Drive.

MP 1.25 - 1.3 (north side)
Remove loose rocks and boulders (photo 7) from top of slope face. Clean, reshape, and pave catchment ditch.

MP 1.35 - 1.4 (north side)
Poor sight distance exists around slope from westbound lane. Very little catchment area for debris. Should remove all loose rocks, boulders, and corestones from slope (photos 8,9,10). It might be necessary to blast to remove large boulders with unfavorable fracture plane orientations. If necessary, care should be used to insure that the house sitting above the cut is not endangered by blasting procedures.

Mp 1.45 - 1.5 (both sides)
Cuts on both sides look ok. Remove any loose rocks and clean talus from catchment area.

MP 1.55 - 1.6 (both sides)
South side cut, no work needed.

North side cut, clean catchment ditch and slope scale loose rocks.

MP 2.0 - 2.1 (north side)
Clean material from behind retaining wall, slope scale loose boulders and rocks (photo 11), and remove any dead undermined trees which could fall onto roadway.

MP 2.15 - 2.3 (north side)
Scale loose rocks from slope. Clean debris from behind wooden retaining walls.

MP 2.35 (north side)
Scale loose rocks from slope, remove talus from catchment area. Large perched boulder should be removed (photos 12 & 13). Boulder will probably require blasting to move. A 6 to 8 inch sand cushion should be used to protect the existing roadway surface from the falling boulder. Fill slope erosion (photo 14) at the beginning of the curve on the westbound lane needs to be addressed. Should provide drainage structure to allow downslope flow without fill erosion. Hydraulics should be consulted on this design.

MP 2.35 - 2.45 (north side to end of wooden retaining wall)
Slope scale loose rocks, boulders, and corestones (photo 15). Clean material from behind retaining walls.

MP 2.45 - 2.5 (north side)
Shotcreted portion of slope is ok. However there is a large precariously (can move boulder with bare hands) perched boulder above the slope (photos 16 & 17). There is a good possibility that this boulder could slide off its perch and bounce onto roadway. The boulder appears to be on private property. We should consider removing this rock if property owner has no objections. Should be

able to drag boulder downslope to a more stable position with winches or heavy equipment. Blasting is not recommended due to the close proximity of the house.

MP 2.6 (north side)
Scale loose rocks from slope (photo 18). Remove large dying undercut tree (marked with blue stripe) to keep it from falling across roadway.

MP 2.65 - 2.75 (north side)
Clean debris from behind wooden retaining walls.

MP 2.75 - 2.8 (north side after retaining wall)
Scale loose rocks from slope.

MP 3.0 - 3.05 (north side)
Two rock outcrops in gaps between wooden retaining walls are ok. No work needed.

MP 3.25 - 3.4 (at summit, north side meshed rock slope)
Need to replace missing bottom weights to retension chain link mesh (photo 19). Alternatively, we could permanently remove mesh and scale loose rocks from slope.

MP 3.5 (north side meshed slope behind jersey barriers)
No work needed on slope, just clean catchment area.

MP 3.65 - 3.95 (north side meshed slope)
Slope condition is acceptable in most areas. We need to replace missing bottom weights as needed. But from about MP 3.8 to 3.95 (photos 20,21,22) most of the upper row of anchors supporting the mesh have failed (probably due to snow and ice loads). Some of the lower row anchors have also failed. As a rule the 1" diameter anchor rebars failed in shear about 2 to 6 inches below the metal plates used to secure the wire rope tendons. None of the anchor piles experienced pullout failure. We could repair the mesh by increasing the number of anchors and retensioning the mesh. The diameter of the rebar may also have to be increased. Bridge Division would need to evaluate this. It appears that anchors are spaced on about 50′ centers at least on the upper row.

A better option would be to remove the damaged mesh from this area entirely. The present condition of the slope doesn't require meshing in our opinion. We also need to clean catchment area behind jersey barriers.

MP 4.0 - 4.4 (north side cut in massive granite)
Scale loose rocks from top of slope (photo 23).

MP 4.4 - 4.45 (north side)
Lots of loose rock, boulders, and corestones exist on this slope (photos 24,25,26). We need to scale all loose rock from slope as a minimum. Consider meshing this slope and placing jersey barriers to help control rockfalls for long term solution.

MP 4.45 - 4.55 (north side)
Scale loose rocks, corestones, and boulders from slope (photos 1A & 2A).

MP 4.55 - 4.7 (north side around curve)
According to Mr. Lopez Maintenance has lots of trouble with this slope, especially with the western portion. It appears that both ripping and blasting techniques were used to construct this cut. Slopes should be scaled of all loose rocks and boulders as a minimum for short term.

For long term mitigation we might consider wire meshing slope as well as realigning roadway curve away from slope face to provide a better catchment area (photos 3A through 7A). Reshaping the slope face, placing rock fall fences, and constructing a "Ritchie" type catchment ditch at the slope toe might also be good design alternatives. These types of solutions will require more extensive field investigation and related office work. Accurate cross sections of the existing slope face will also be needed for such designs. Currently, this information is not available.

The smaller rock cut along the outside radius (south side) of this curve only needs minor slope scaling to remove loose rocks.

MP 4.8 - 4.9 (both sides)
Scale loose rocks from slopes only.

MP 5.0 - 5.05 (west side)
Slope scale loose rocks only.

East side slope needs no work.

MP 5.1 - 5.15 (north side)
A spring area exists near toe of slope. Scale loose rocks and place jersey barriers to contain ravelling material (photo 8A).

South side slope needs no work.

MP 5.2 - 5.3 (north side)
Mainly a soil slope. No work needed.

MP 5.35 - 5.45 (north side)
A spring exists in slope toe which is fitted with a PVC pipe for a water supply. West of spring slope is highly fractured and weathered. Lots of cobble sized material reaches roadway (photos 9A, 10A, & 11A). Material is so broken up scaling won't help much.

Recommend containing material by placing wire mesh on slope, cleaning up catchment area of debris, and placing jersey barrier rail along edge of oil.

Portion of slope south of spring is more massive & bleached. Recommend scaling loose rock from slope and placing jersey barrier rail to keep ravelling debris from reaching travel way.

MP 5.5 - 5.85 (both sides)
Serrated stepped rock slopes that were constructed using ripping techniques. Slope scale loose rocks, especially near slope crest. No other work needed.

MP 5.9 - 6.1 (both sides)
Serrated stepped ripped slopes (photo 12A). Clean catchment areas, and scale loose rocks and boulders from face.

MP 6.2 - 6.4 (west side)
Ripped slope. Clean catchment area, slope scale loose rock and boulders especially near the start of the cut near MP 6.2.

MP 6.5 - 6.6 (south side)
Single benched slope (photos 13A, 14A, & 15A). Bench is full of talus. As a minimum talus should be removed from bench and slopes should be scaled of all loose rock, catchment area should also be cleaned. Good access to bench is available from west side. Wire mesh could be used to control rockfalls for long term, especially on the cut face below the bench. Placement of rock fall fencing on bench might also be a good option.

North side cut has good catchment area. Only need to clean and reshape ditch.

MP 6.65 - 6.75 (south side)
Well vegetated slope. Scale loose rocks and boulders. Recommend placing jersey barrier rail at edge of oil to control ravelling debris.

MP 7.0 - 7.1 (south side)
Existing cut slope is in good shape. Could place jersey barriers to keep ravelling debris from reaching travel way otherwise leave as is.

North side has small cut which is in good condition and needs no work.

MP 7.15 - 7.25 (south side)
Scale minor loose rock from face, no other work is needed.

North side cut in good condition. Just clean ditch.

MP 7.3 - 7.5 (west side)
Single benched slope. Need to clean talus off bench (photos 16A & 17A). Slope below bench is highly fractured and weathered. Minor scaling of this portion of the slope is all that is needed.

East side cut needs minor scaling only.

MP 7.55 - 7.75 (west side)
Single benched slope (photos 18A & 19A). Bench has no access but doesn't need to be cleaned because trees on bench form natural rock barrier. Only really need to scale loose rocks from portion of slope below bench. If bench is cleaned the existing trees and brush should be left as undisturbed as possible.

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Please note that the next 2 slopes were located from different milepost markers as seen in the field. It appears that 1.2 miles actually exist between mileposts 7.0 and 8.0 as posted in field.
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MP 7.8 - 7.95 (both sides, measured fm MP 7.0 as posted in field)
Single benched slopes (photos 20A, 21A). A very steep access exists on the south side of the west bench. A gas line crosses and a water line is buried on west bench. Quite a bit of talus has built up on west bench. Bench also has trees and brush which form natural rock barrier. Recommend cleaning talus from bench but should try to retain as many trees and bushes as possible.

East bench has no access but doesn't need to be cleaned.

We should slope scale loose rocks off both cut faces below benches. Recommend placing jersey barriers along edge of oil to prevent debris from reaching roadway.

MP 7.8 - 7.95 (south side, measured back from MP 8.0 as posted)
Single benched slopes separated by drainage gully (photos 24A, 1B). These slopes are located just below the slopes described in the previous paragraph. Milepost 8.0 appears to be field posted about 0.2 miles to far down slope from milepost 7.0. A small spring\seep is located at toe of cut (photos 1B, 27A). This is probably the reason for a bump sign placed to warn motorists at this location (possible freezing water under roadway during winter months). Should consider subsurface field investigation at this site to confirm this. May need to place some sort of underdrain to mitigate "bump" problems during winter months.

West bench is inaccessible and full of talus (photo 25A) which needs to be cleaned. Rocks dropped to roadway surface as we crossed it. Cut slopes above benches should be ok after benches are cleaned (photo 26A). Cut slopes below benches are badly broken up, weathered, and have evidence of large wedge failures (photo 2B). Due to the badly eroded and fractured nature of these slopes

wire meshing probably would not help without first scaling and reshaping the slope faces. Construction of a catchment ditch below these slopes would also be prudent. In order to provide proper design recommendations for these slopes more extensive field work will be necessary. For the short term we recommend slope scaling the existing slopes of all loose rock and placing jersey barrier rails along edge of oil to help intercept rock fall debris. These slopes will require frequent monitoring and maintenance until long term mitigations are designed and constructed.

The north side cut needs minor scaling only.

MP 8.0 - 8.1 (both sides)
A difficult access exists to south side bench at east end of cut (photos 22A, 23A). Should clean bench and slope scale both sides of cut.

MP 8.15 - 8.2 (south side)
Massive weathered granite cut which is soil like in places (photo 3B). Single bench supports dirt road which begins at green gate near MP 8.1. Need to slope scale loose rocks, corestones, and boulders from lower slope. Should also clean ditch of debris. No work needed on bench or slope above bench.

MP 8.25 (south side)
Small cut, scale loose rocks and clean ditch.

MP 8.35 - 8.6 (south side)
Slope is blocky, rough and ravelling. Face has developed gullies due to erosion processes (photos 4B though 8B). Overhead power lines are supported on crest along western portion of cut. Eastern portion of slope has single bench which wraps around corner. A spring\seep is located about halfway up the slope below the bench. At a minimum all loose rock should scaled from cut faces, and the bench should be cleaned of debris. Access to bench is available from the east side via a dirt road located above the cut.
A good long term solution would be to widen the cut by 10 to 15 feet to provide a catchment area. Wire mesh could also be useful here but there is very little catchment area at the toe of the cut.

The northside cut should also be scaled. The ditches along both sides should be cleaned.

MP 8.75 - 8.85 (west side)
Single benched slope (photos 9B, 10B, & 11B). About midway into the cut the bench has failed all the way back to the upslope face. Best short term solution would be to slope scale above and below bench. Bench should also be cleaned of debris. Placement of jersey barriers below the failed bench would help contain debris.

A good long term solution could be to cut the slope back to eliminate the bench along with constructing a catchment ditch at

the toe of the new cut face. As before more detailed field investigations\office work will be needed to provide design recommendations for these types of solutions.

The east side of this cut is in better shape and only needs to be scaled.

MP 9.0 - 9.15 (west side)
Bench has several large talus cones which have nearly covered it (photos 12B through 17B) especially along the north half of the bench. These should be removed. Bench has also failed near the north end of the cut. Best short term solution would be to slope scale cut faces and remove talus cones from bench. Placing jersey barrier rails along the toe of the cut where the bench has failed would help contain debris. Best long term solution would probably be removal of bench and construction of a properly design catchment ditch. More field and office work would be needed for this design.

The east side of this cut is in better shape. Should slope scale loose rock from lower slope, and remove talus from north portion of bench below the high cut face. The southern portion of the bench away from the high cut face is in good condition. There is good access to benches on both sides from south end.

MP 9.3 - 9.45 (west side)
Large talus cones have built up on bench (photo 18B). These should be removed. Good access to bench from both sides. Slope scale cut face below and above bench (photos 19B,& 20B) and clean catchment ditch.

East cut slope has no bench. For short term slope scale loose rocks and boulders (photo 21B). Slope has evidence of large slip outs. But to solve these problems long term we would probably have to reshape entire face and construct a catchment ditch. As before more field and office work would be needed to provide proper design recommendations.

MP 9.5 - 9.6 (west side)
Single benched slope. Heavy talus has built up on bench (photos 22B through 27B). Upper cut slope face is very irregular, weathered, and broken up. Bench has failed approximately halfway into cut but is salvageable in most places. For short term solution we need to remove the debris from the bench and slope scale all loose material from the cut faces. Long term solutions could entail cutting back the upper slope to provide a larger catchment bench, placement of rock fall fences, and construction of a catchment ditch at the slope toe. As before more field and office work would be needed to complete such designs. There is good access to the bench from the north side.

The east side cut only needs slope scaling.

MP 9.7 - 9.8 (east side)
This cut has a small double bench (photos 3C, 4C, 5C, & 7C). Neither bench is wide enough to efficiently catch rock fall debris. Long term solutions would probably entail reshaping entire face of cut, eliminating one of the benches, placing rock fall fencing, and providing a catchment area at the toe of the cut. As before more detailed office and field work would be needed to provide good design recommendations.

For the short term slope scaling and removal of the debris present on the benches is recommended. There is a narrow steep access to the benches from the south side.

The west side of this cut has a lower bench that is full of talus (photos 2C & 6C), and a small upper bench of which the middle third has failed. For short term slope scaling and removal of the talus on the lower bench is recommended as a minimum. Long term solutions could entail reshaping the entire slope face, possibly rebenching the slope, placing rockfall fencing, and constructing a catchment ditch at the toe.

MP 9.85 - 10.0 (west side)
Slope scale loose rock, clean and reshape ditch. No other work needed.

MP 10.1 - 10.25 (west side)
Single benched slope. Clean talus from bench. Try to retain as many trees and brush as possible (photo 8C).

MP 10.3 -10.5 (west side)
Cut has large catchment area. Only needs to be slope scaled especially at bend in road to end of cut where catchment area is narrow (photo 9C).

MP 10.6 - 10.7 (west side)
A single low bench exists at toe of cut (photos 10C & 11C). The upper slope face is irregular and broken up. Recommend removing talus from bench. Also should slope scale loose rock from upper slope and clean ditch at toe of cut.

From a geotechnical standpoint several of the rock slopes along this roadway are in dire need of major rehab work. Additionally, snow storage problems at several of the narrow roadway cuts were mentioned by Mr. Lopez. These problems could be addressed as well. However, as mentioned previously more detailed field investigations and related office work will be necessary to properly design corrective long term mitigative measures for these problems. Also, site specific topographic information (ie..cross sections, alignment info, etc.) will be needed before this work can be done. Currently this information is not available to us.

At the present time it is understood that the established budget limitations and time constraints set for this project will not allow long term mitigation designs to be completed for these slopes by the Geotechnical Section. If the project scope is changed to address these problems the Geotechnical Section will obviously need additional time in order to properly address the problems listed above.

Should you have any comments or questions please feel free to contact me at 687-5520.

PN:jms

Enclosures

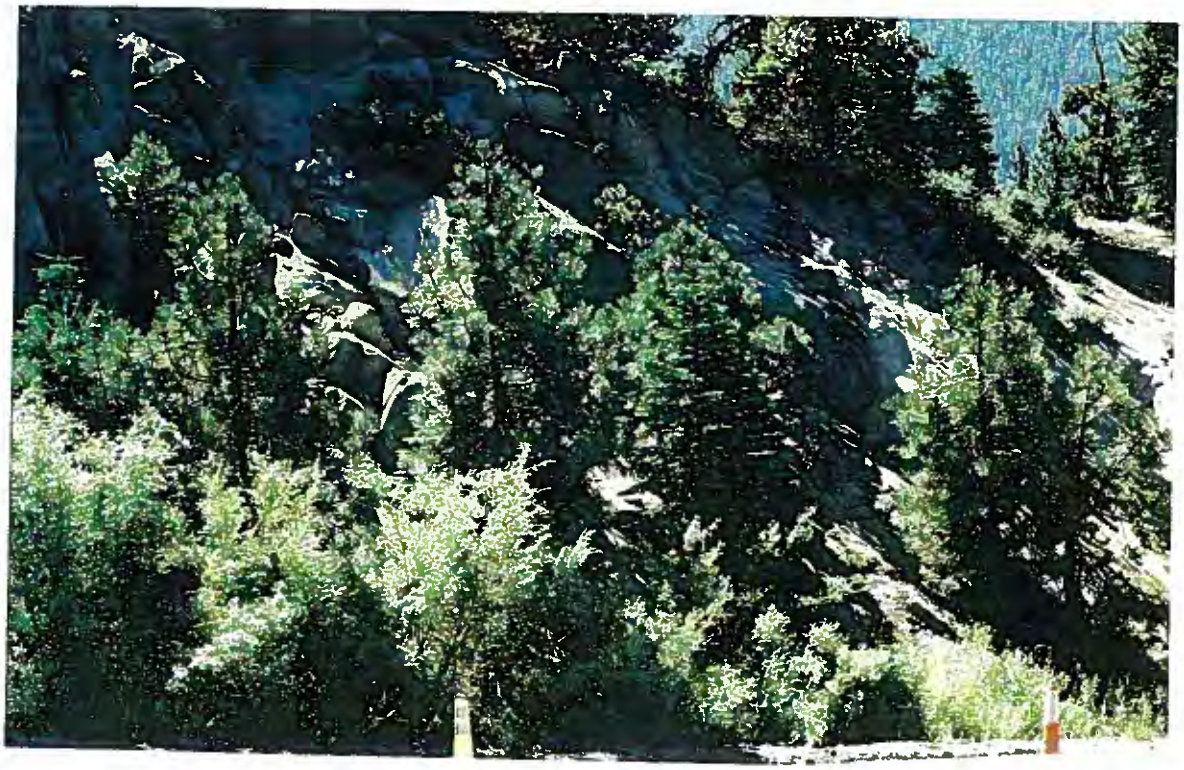
c:

Floyd Marcucci, Bridge
Amir Soltani, Hydraulics
Rick Nelson & George Jordy (1), District 2
Kelly Anrig, Roadway Design
Gary Anderson, Specifications
Rudy Malfabon, Construction
Dan Lopez, Gardnerville Maintenance Station

#1 (Lakeside)

#2

#3 (Lakeside)



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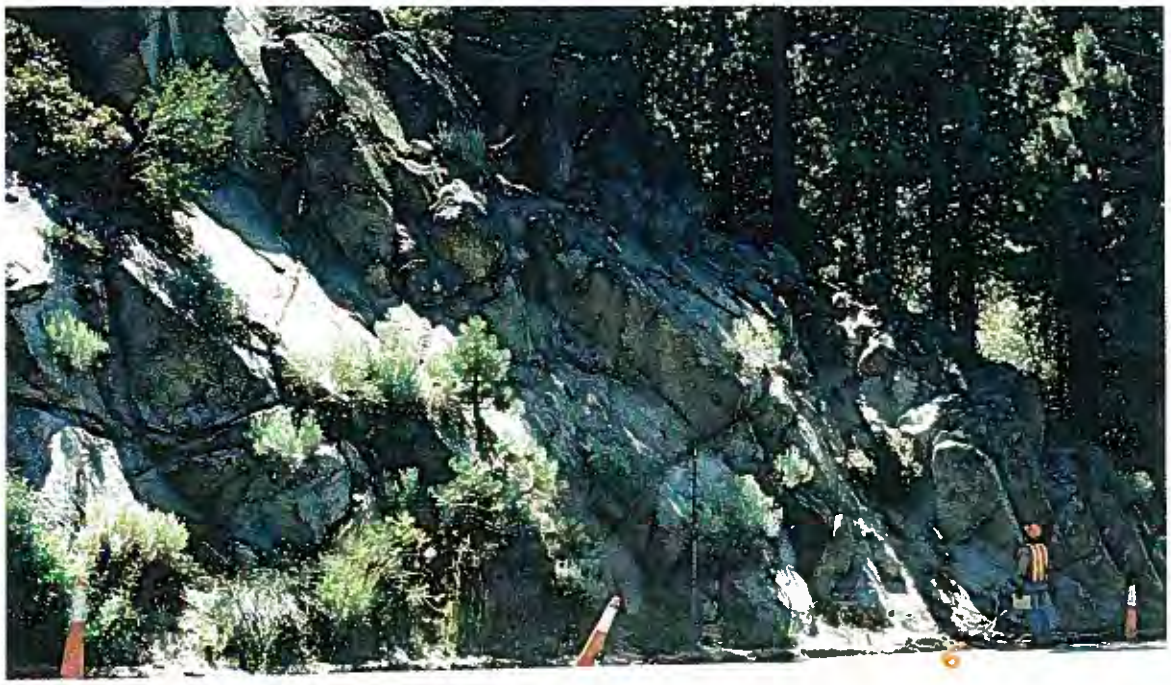

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#7 (Lake side)

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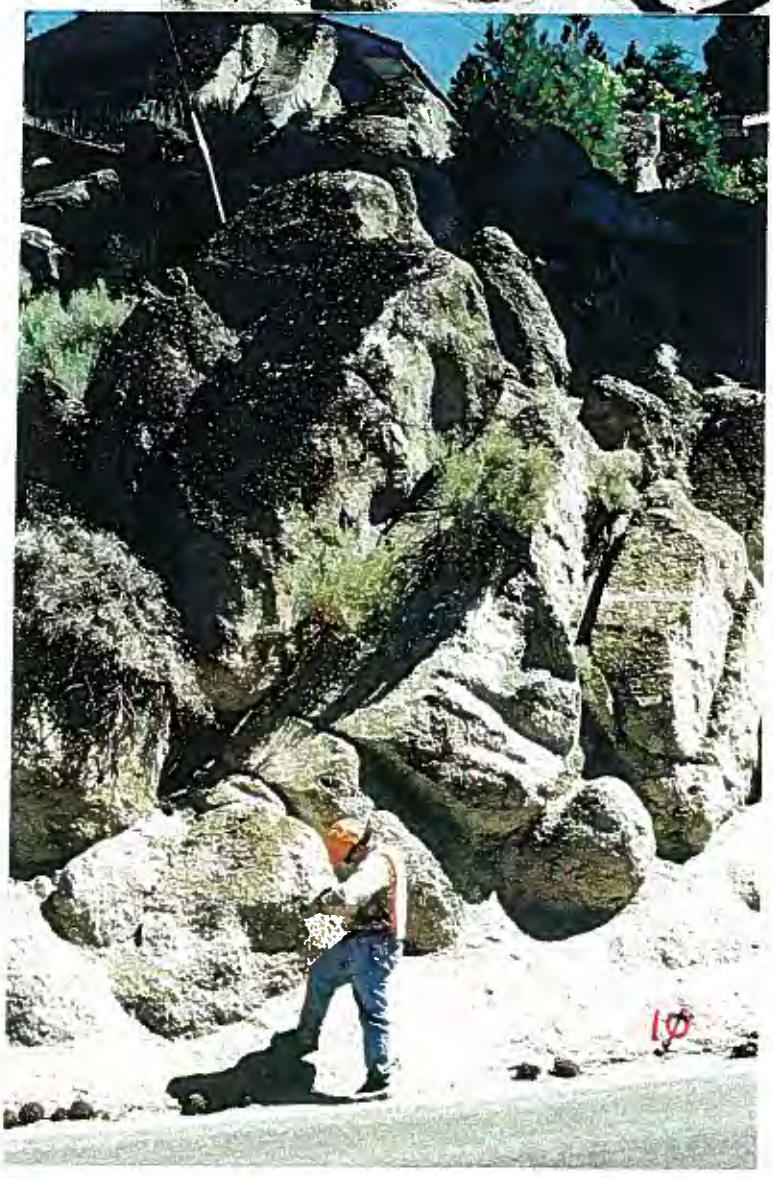
#9 (Lakeside)



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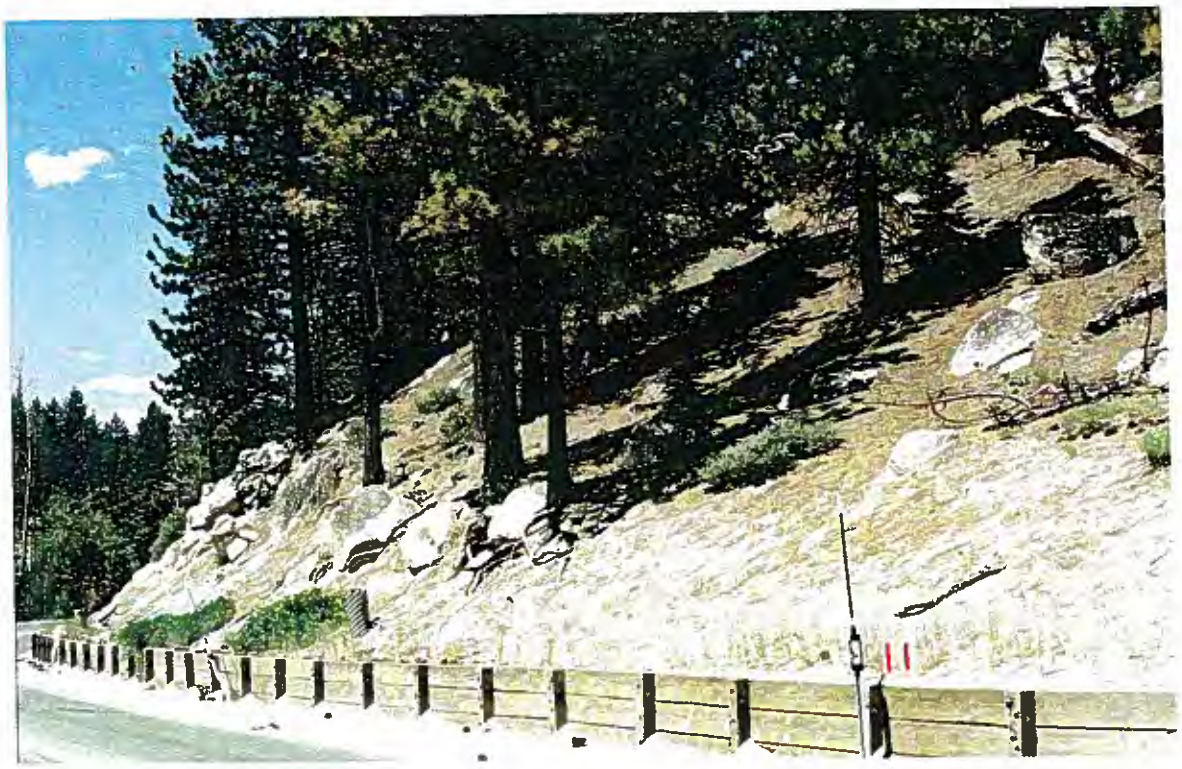
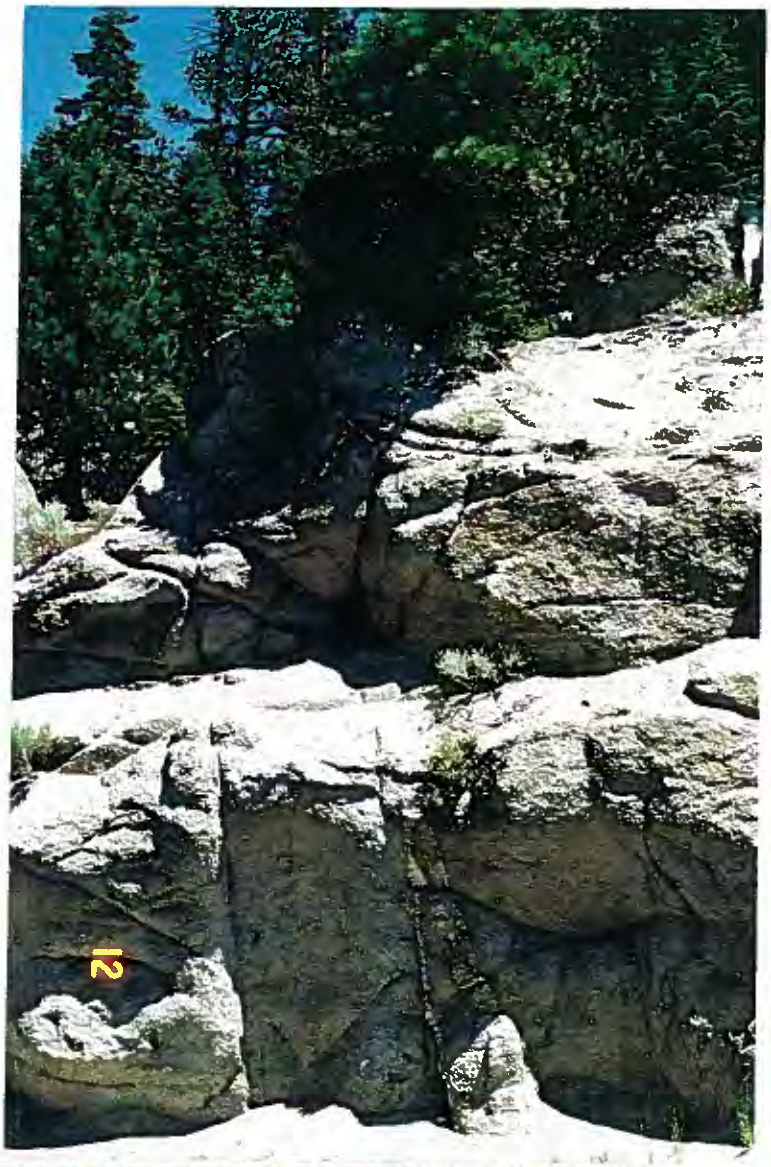


#11 (Lake side)

#12 (Lake side & Summit)



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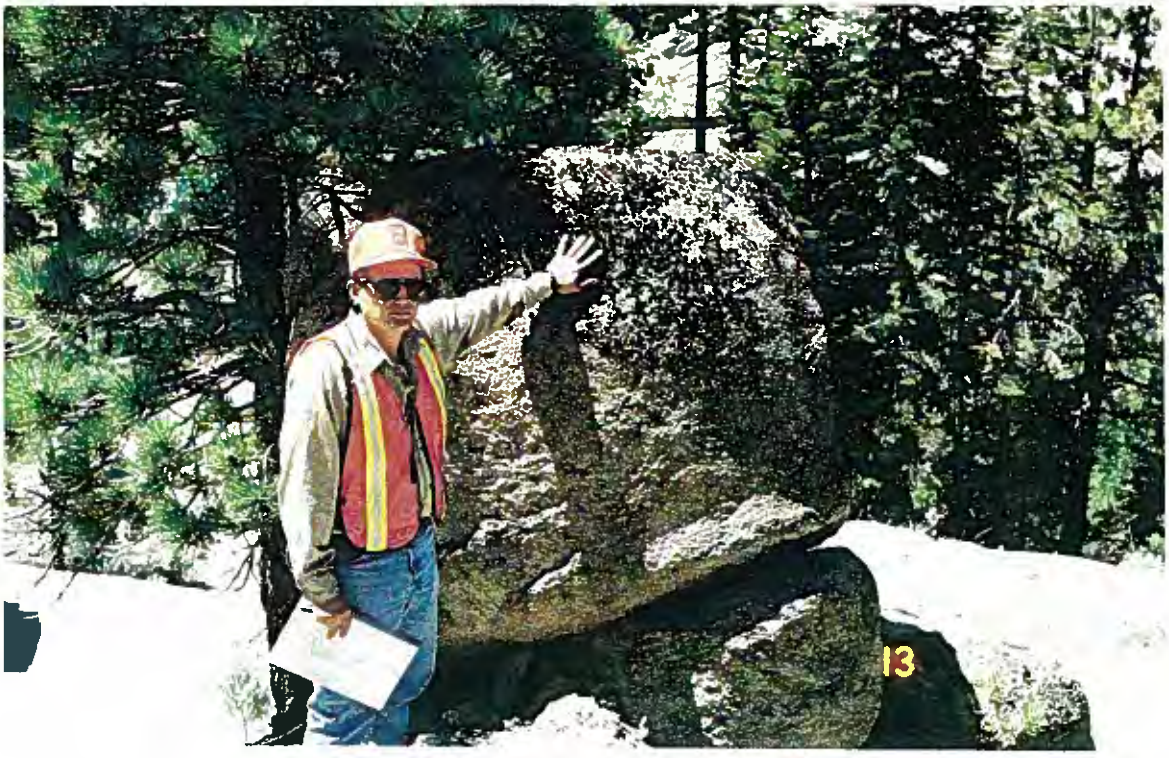

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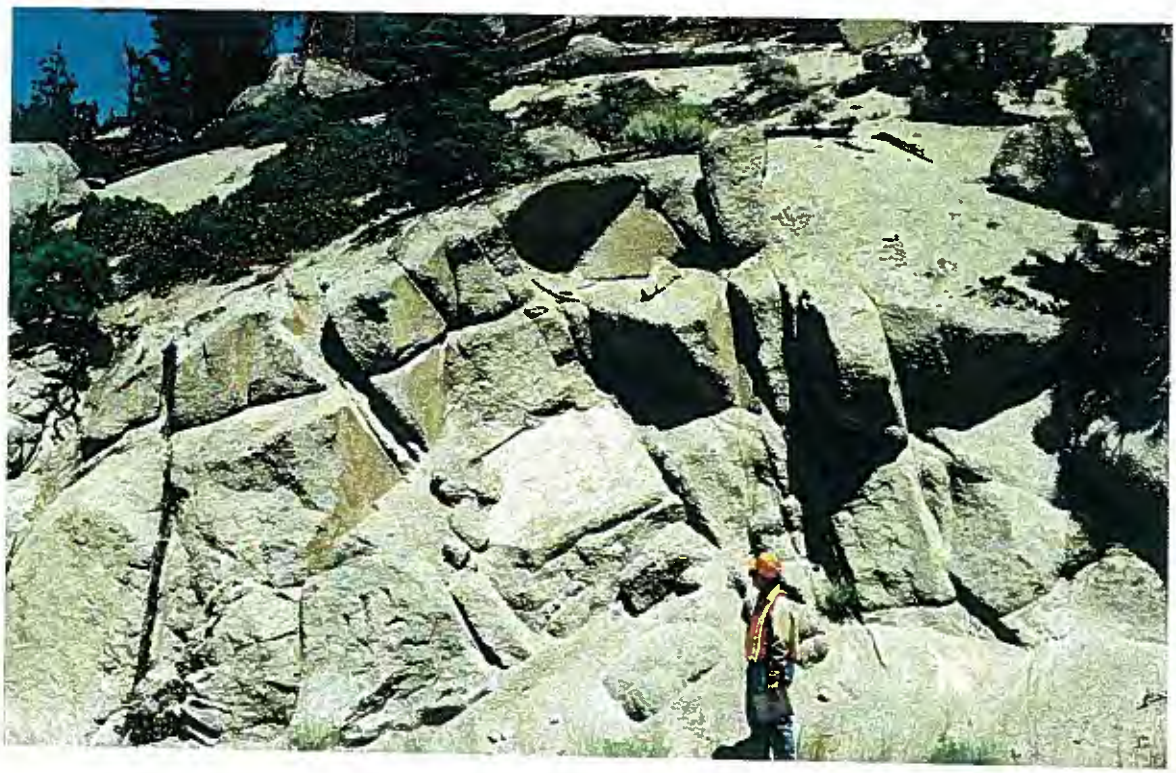

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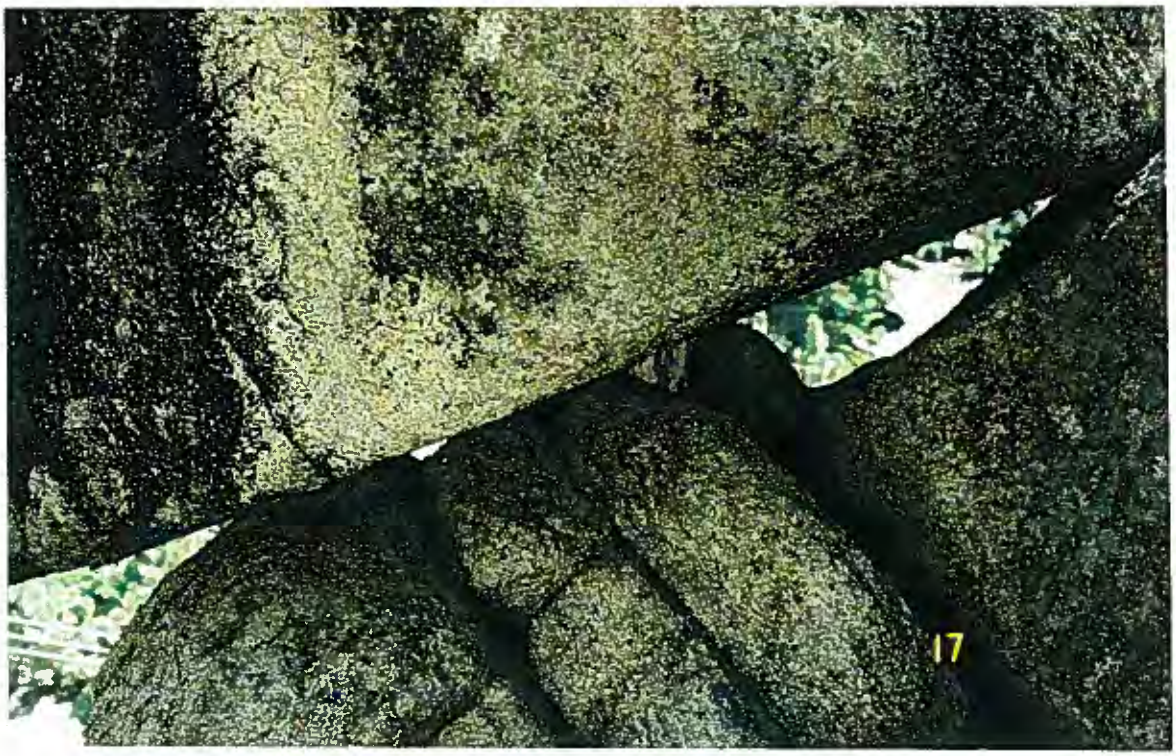

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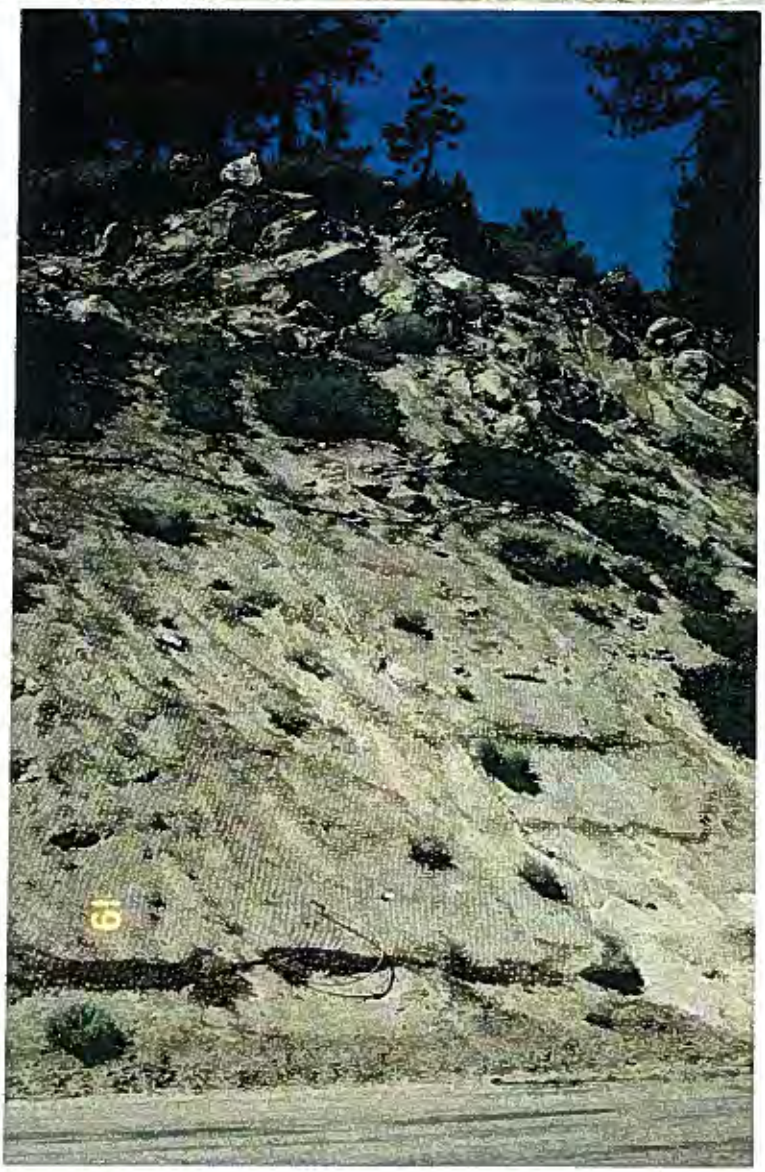

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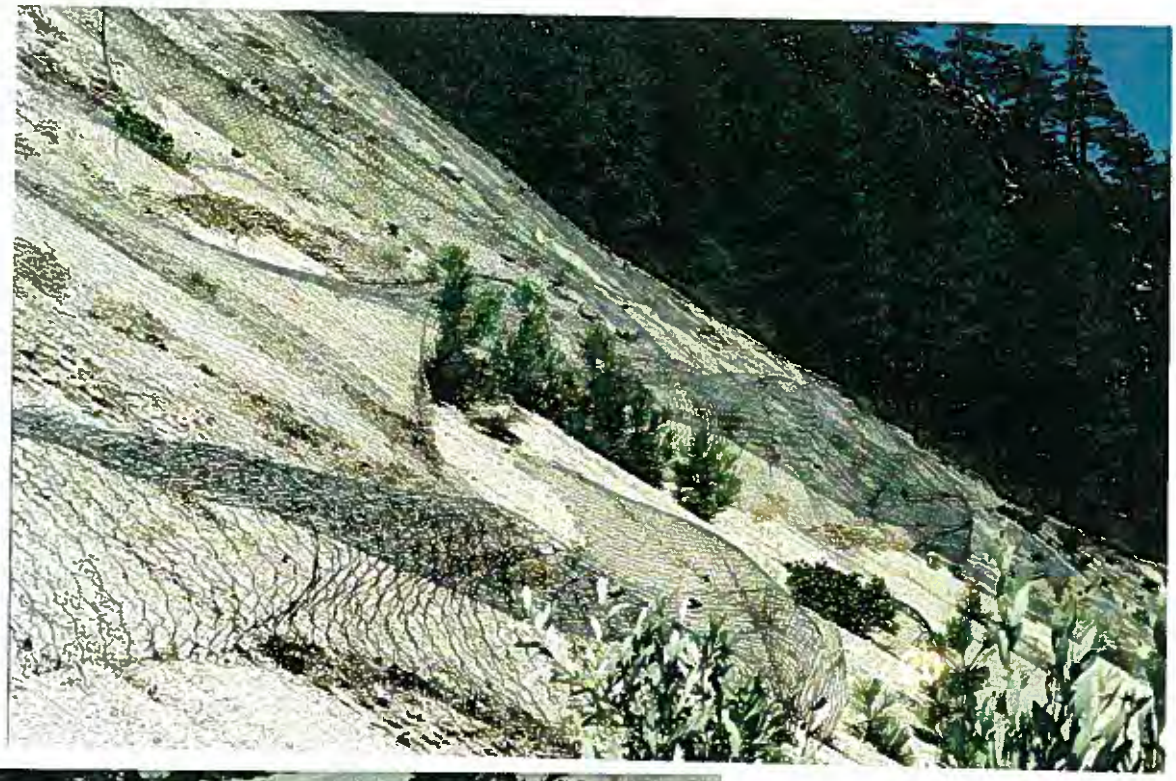

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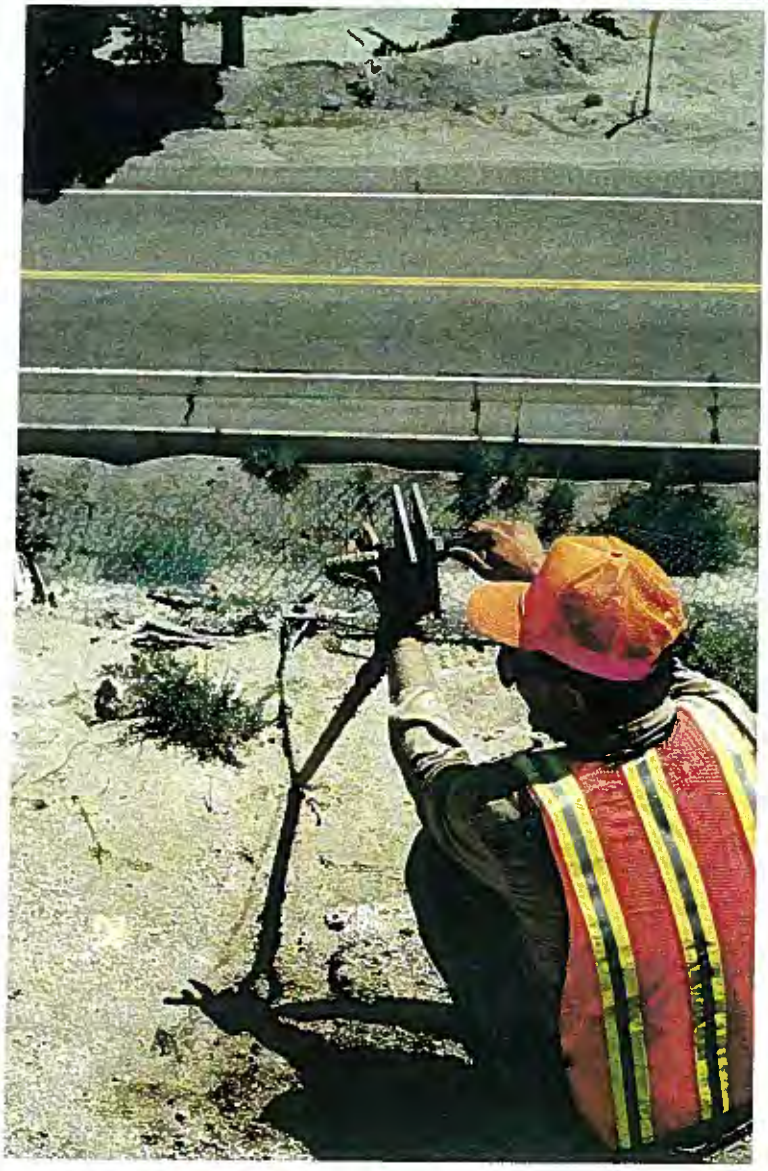

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#22 (Lakeside & Summit)

#23

#24 (Lake side & Summit)

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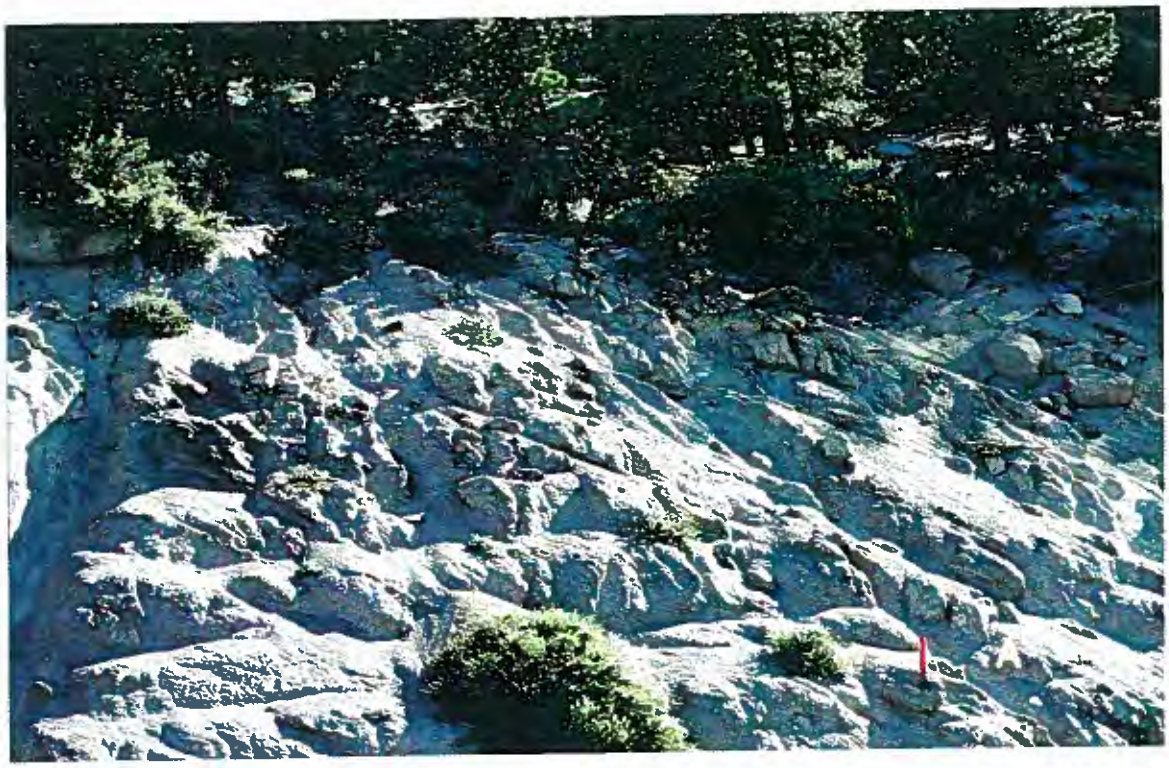
#26 (Lake side & Summit)



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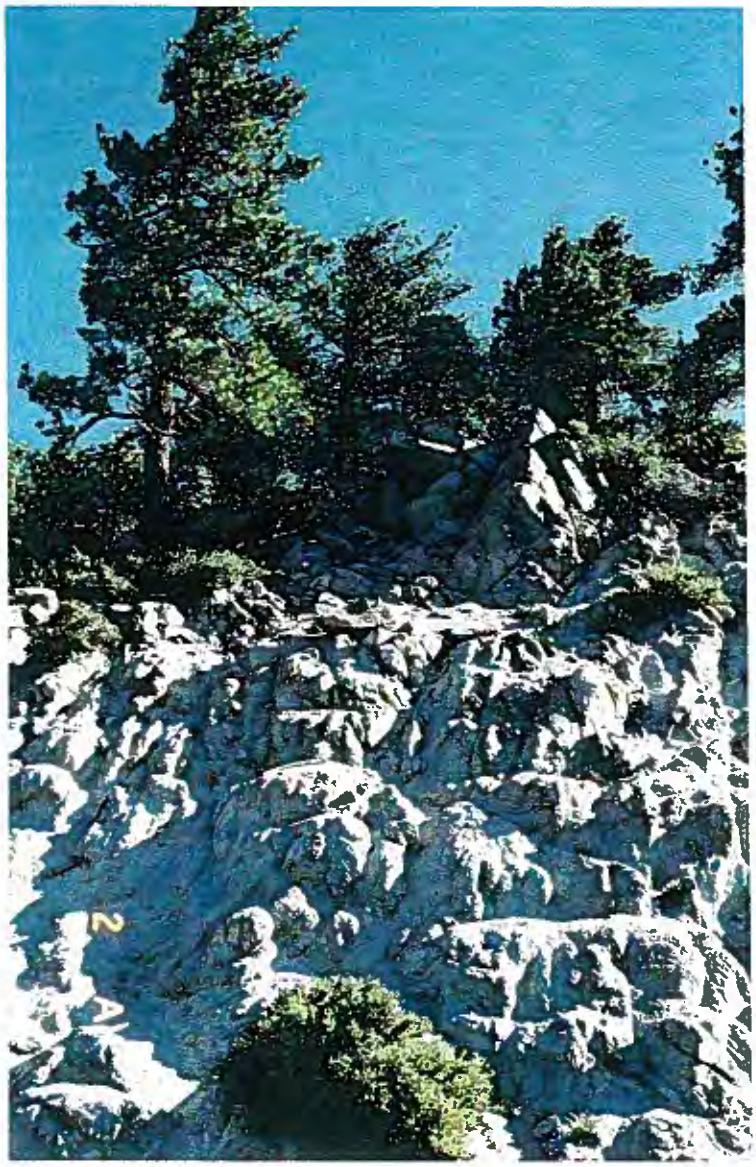

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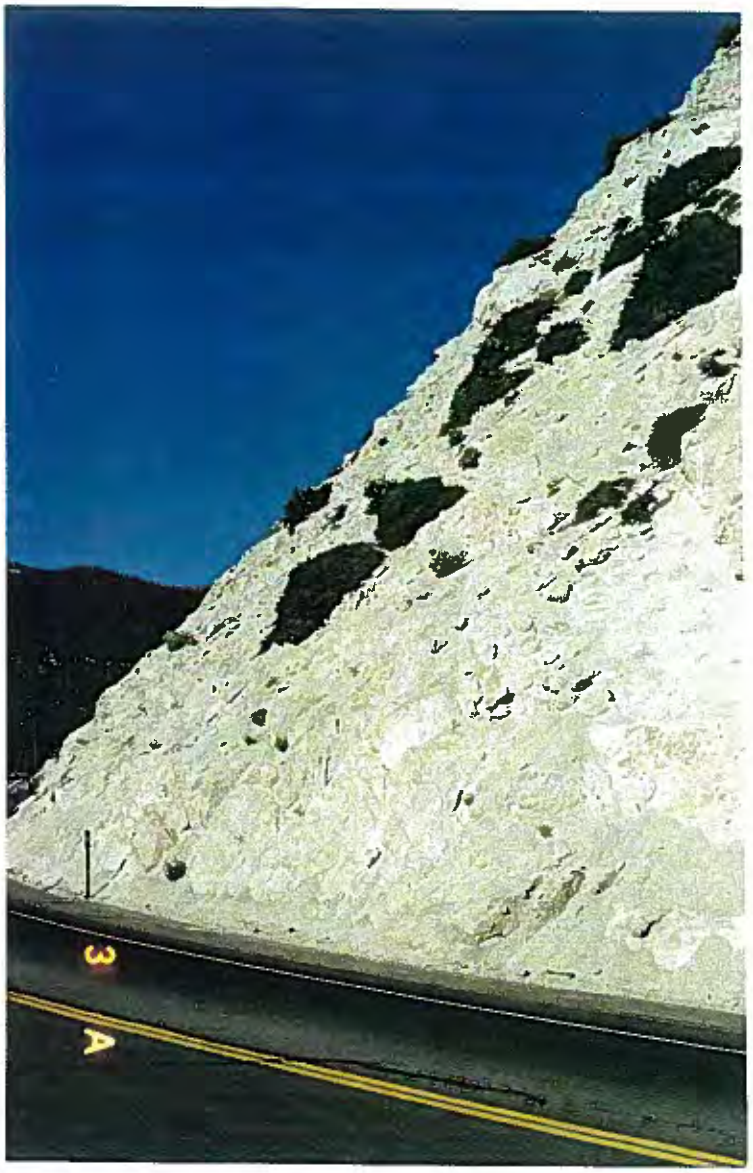

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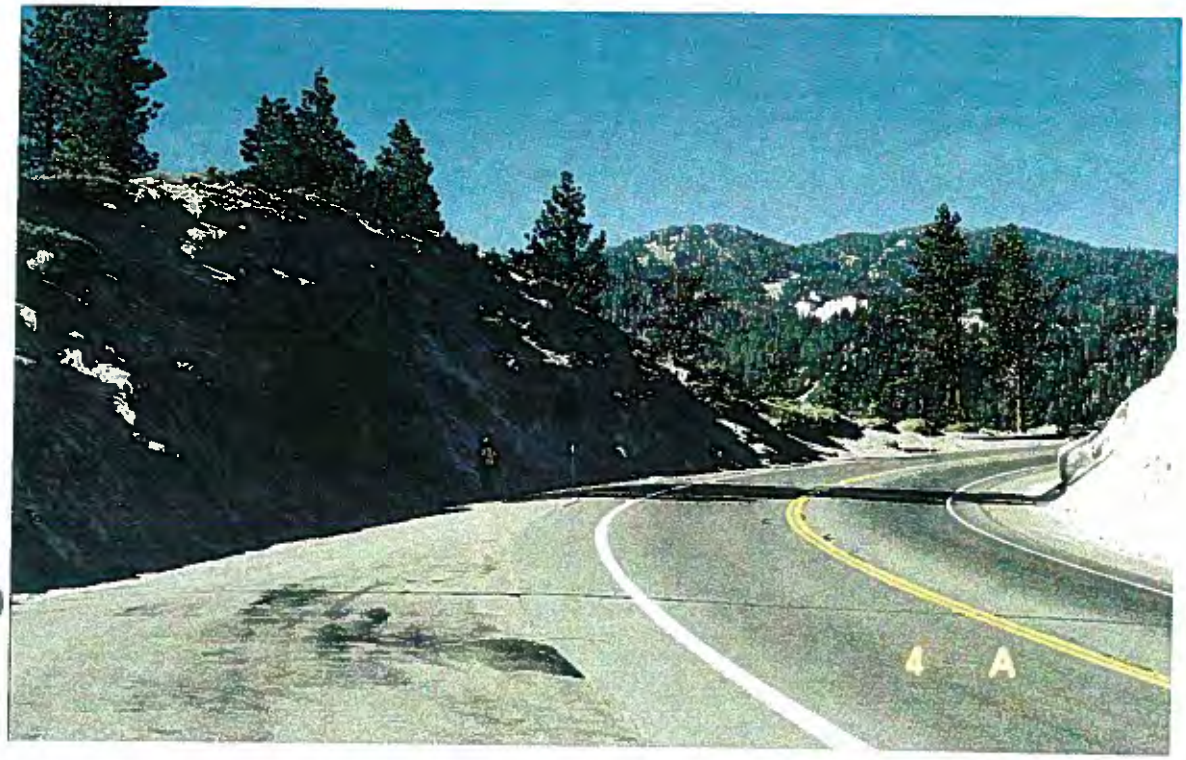

#5A (Minden side)

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#7A (Minden side)

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#9A (Minden side)

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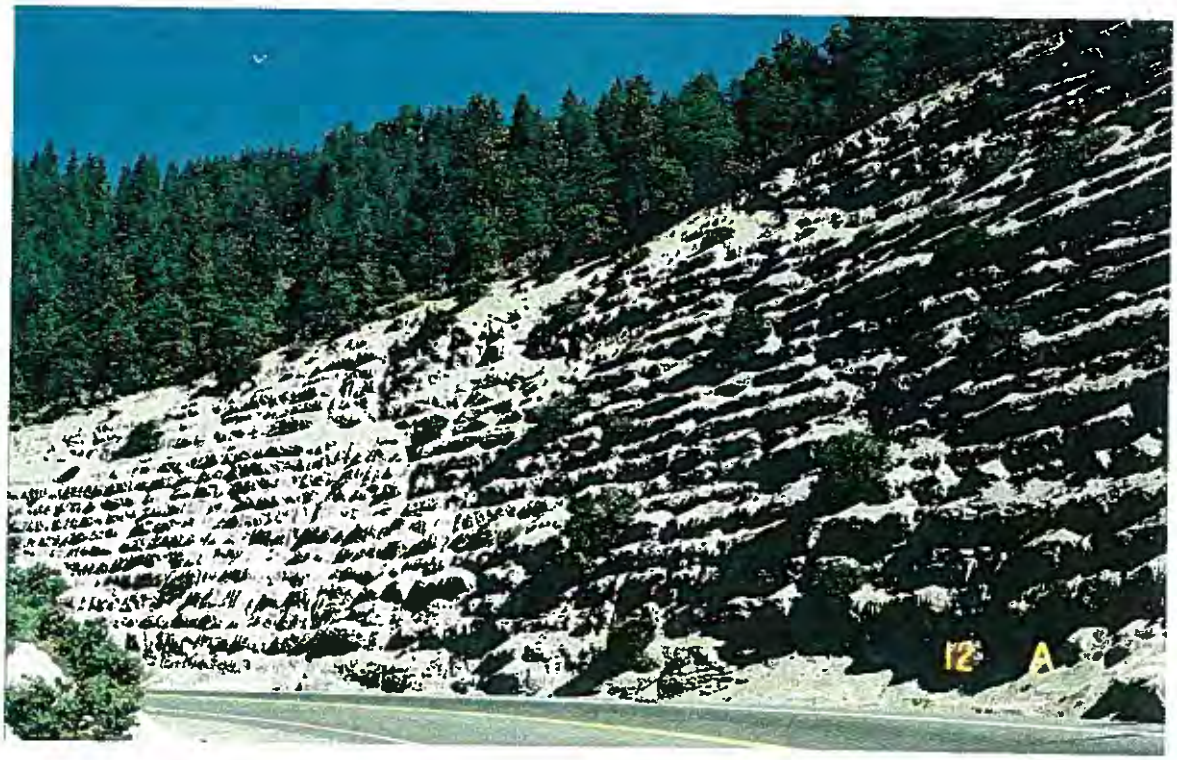
#11A (Minden side)



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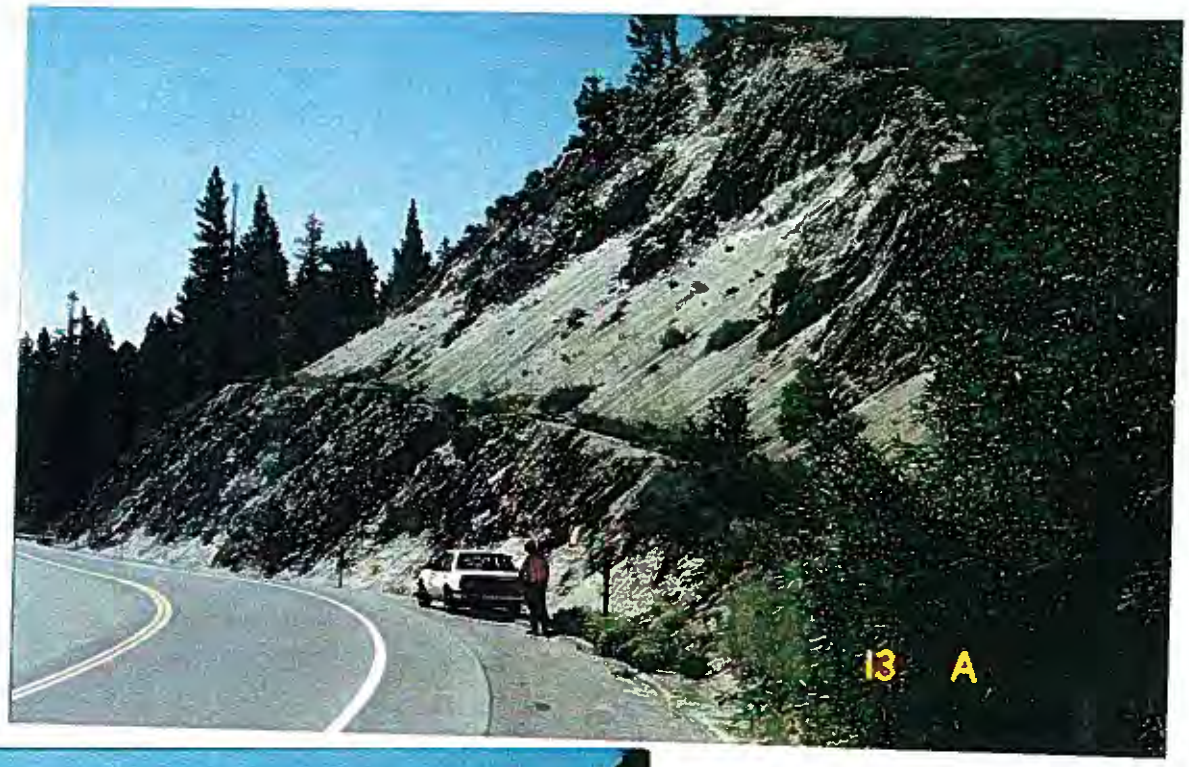
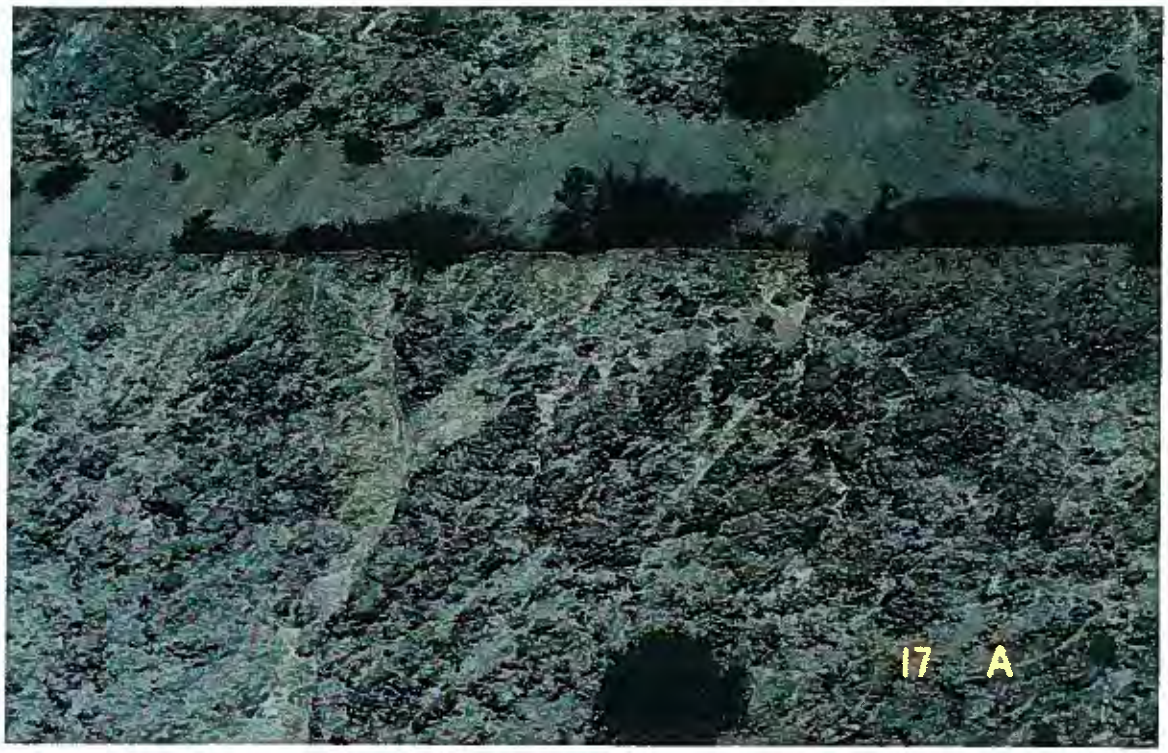


#13A (Minden side)

#14A

#15A (Minden side)

#16A



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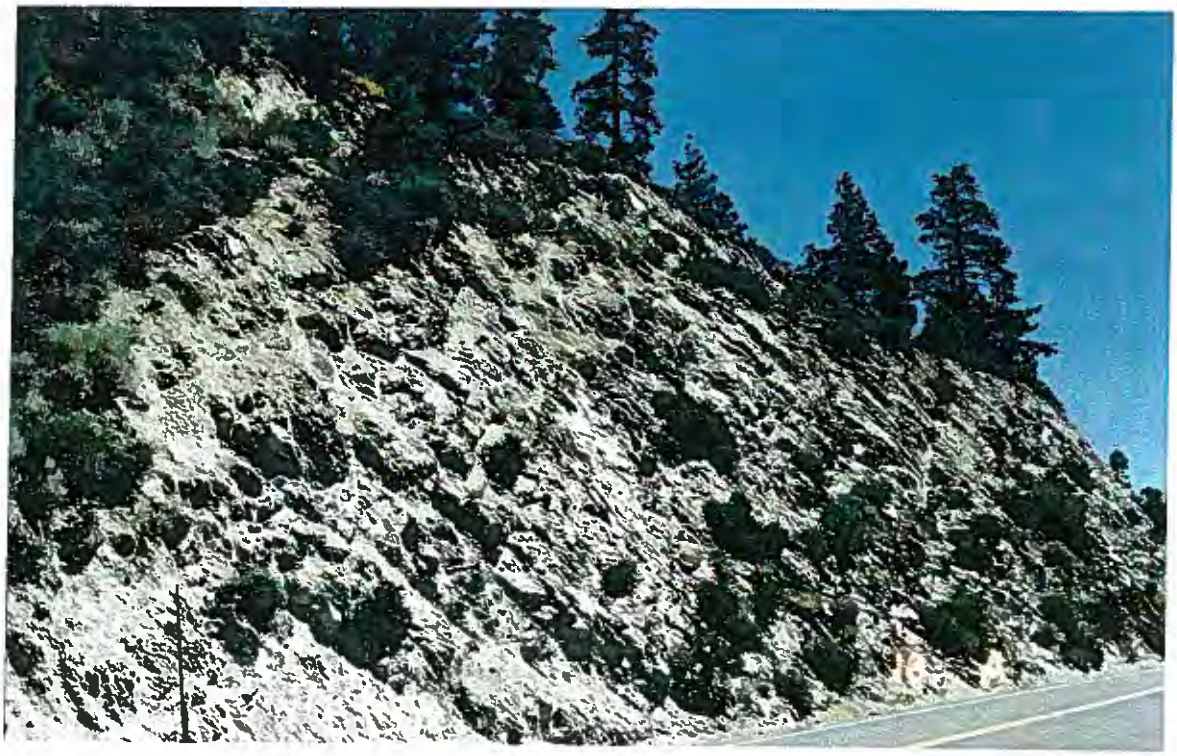

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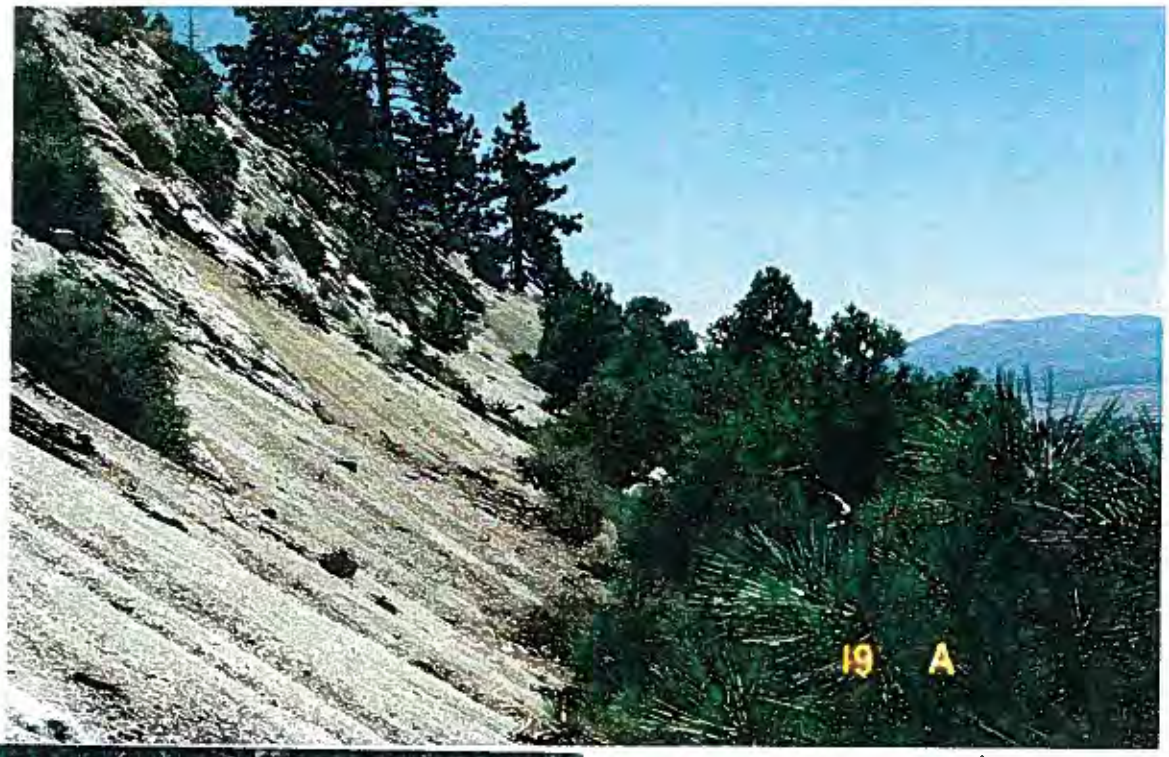

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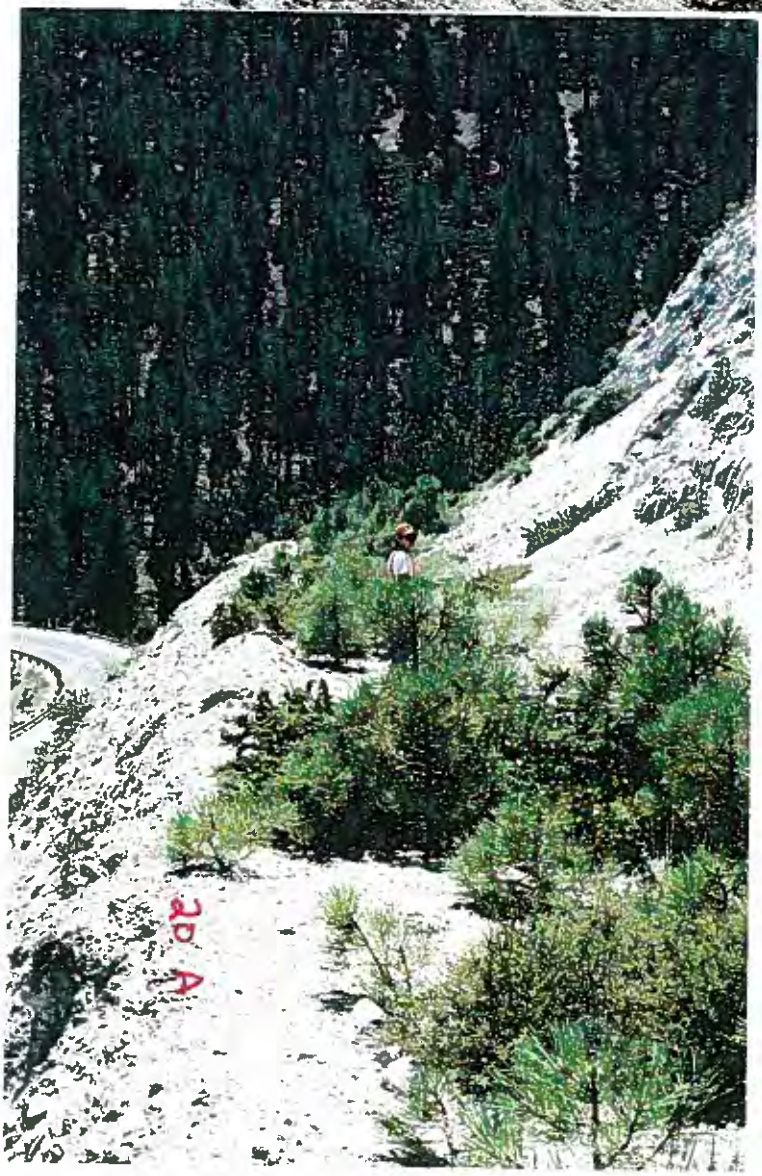
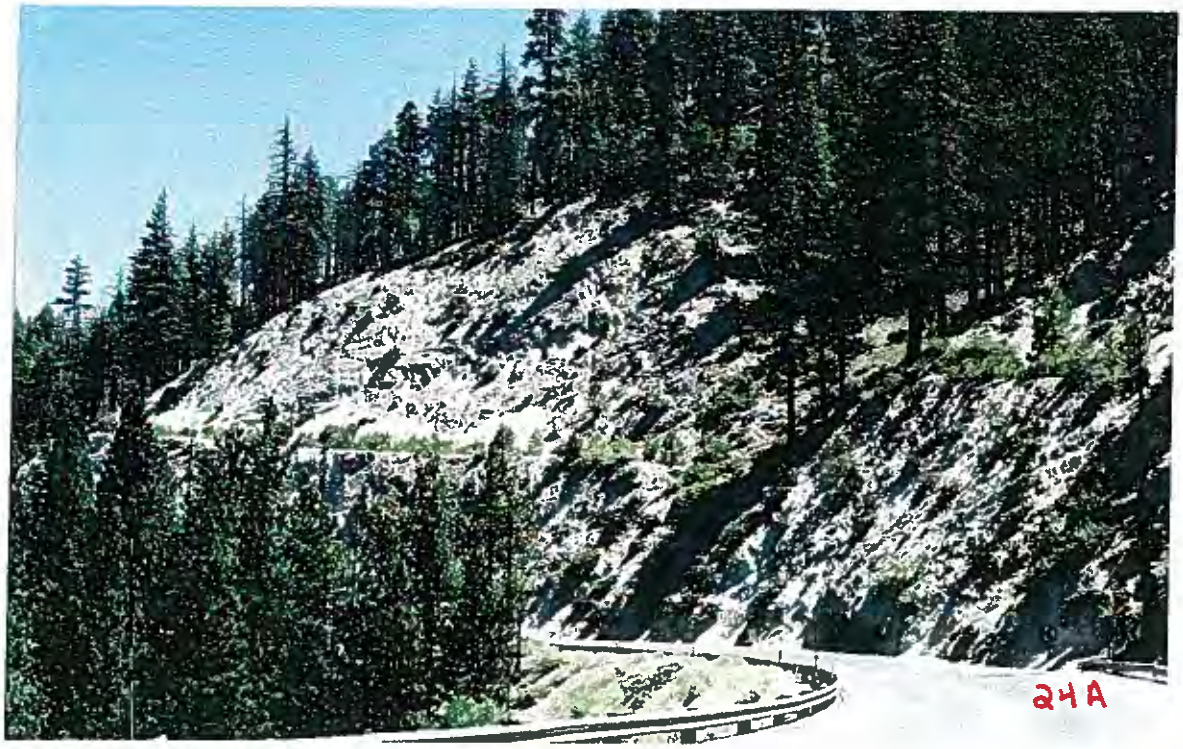


#20A

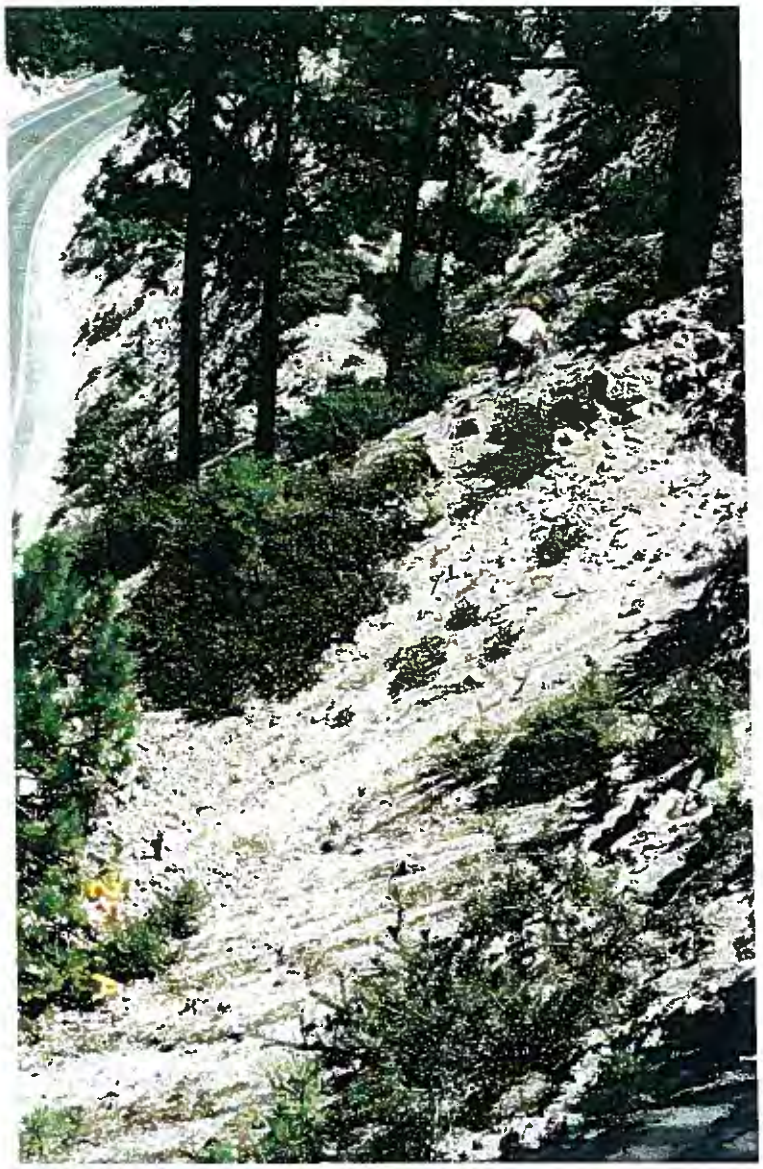
#21 A (Minden side)

#22 A

23 A (Minden side)

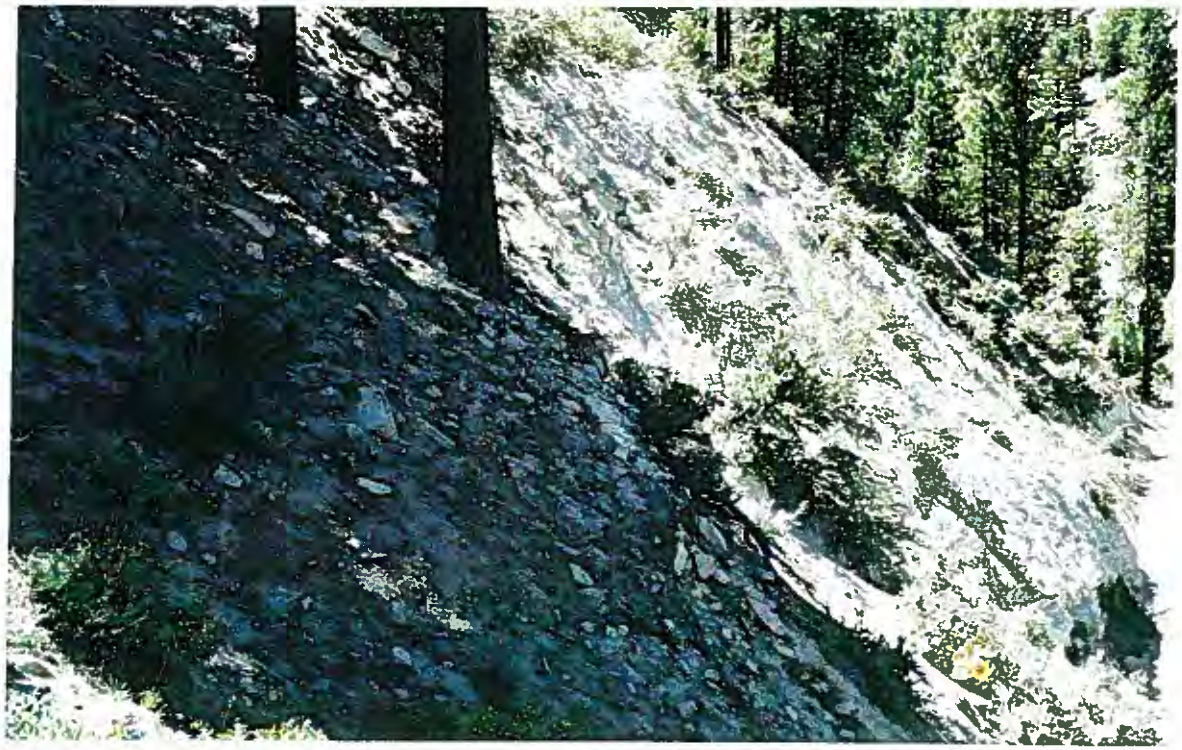


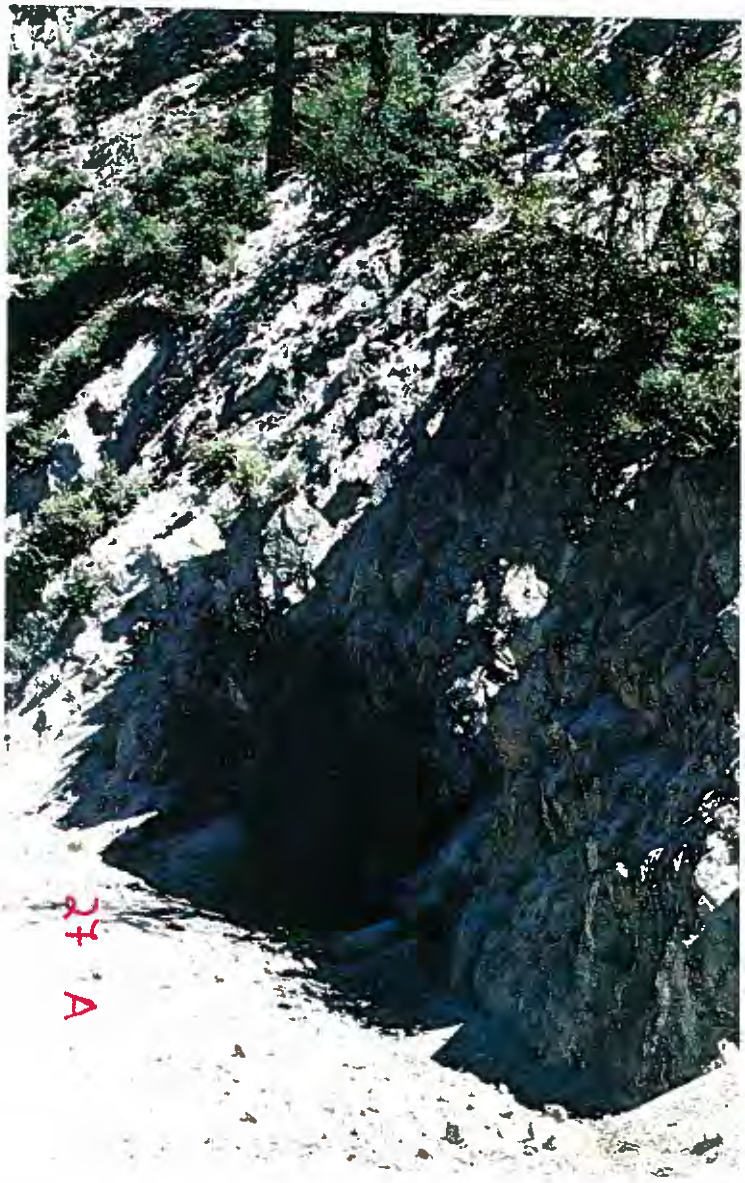
24 A



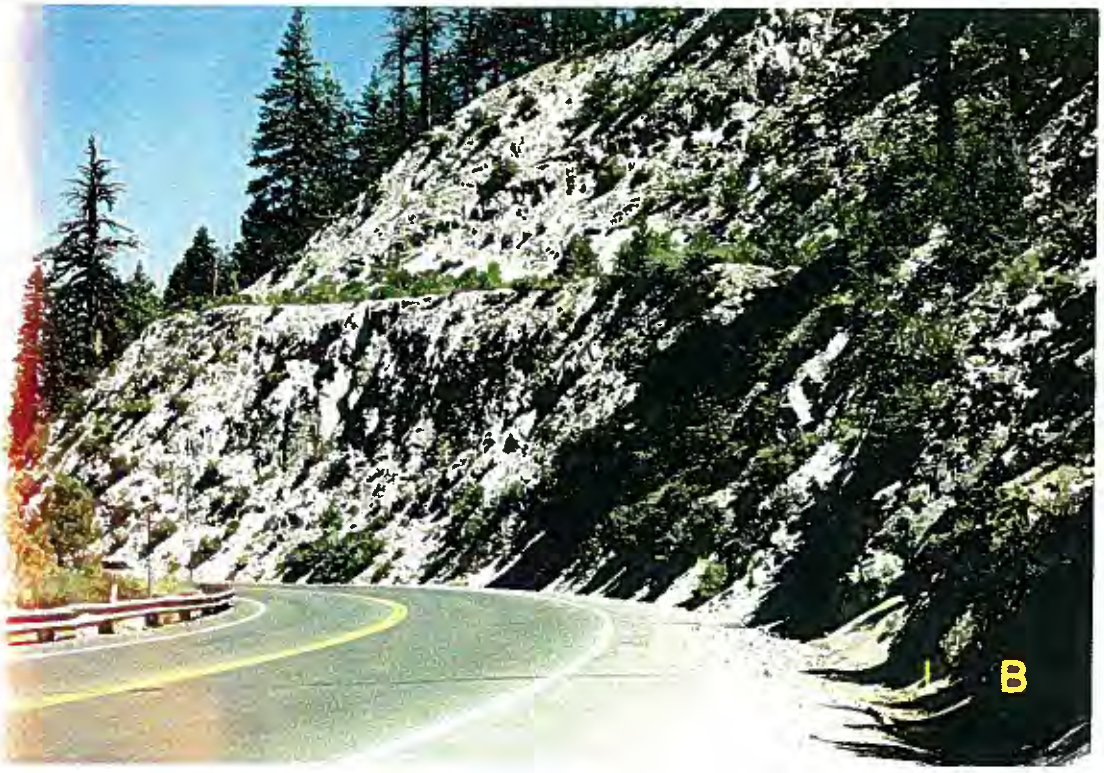
#25A (Minden side)

#26A



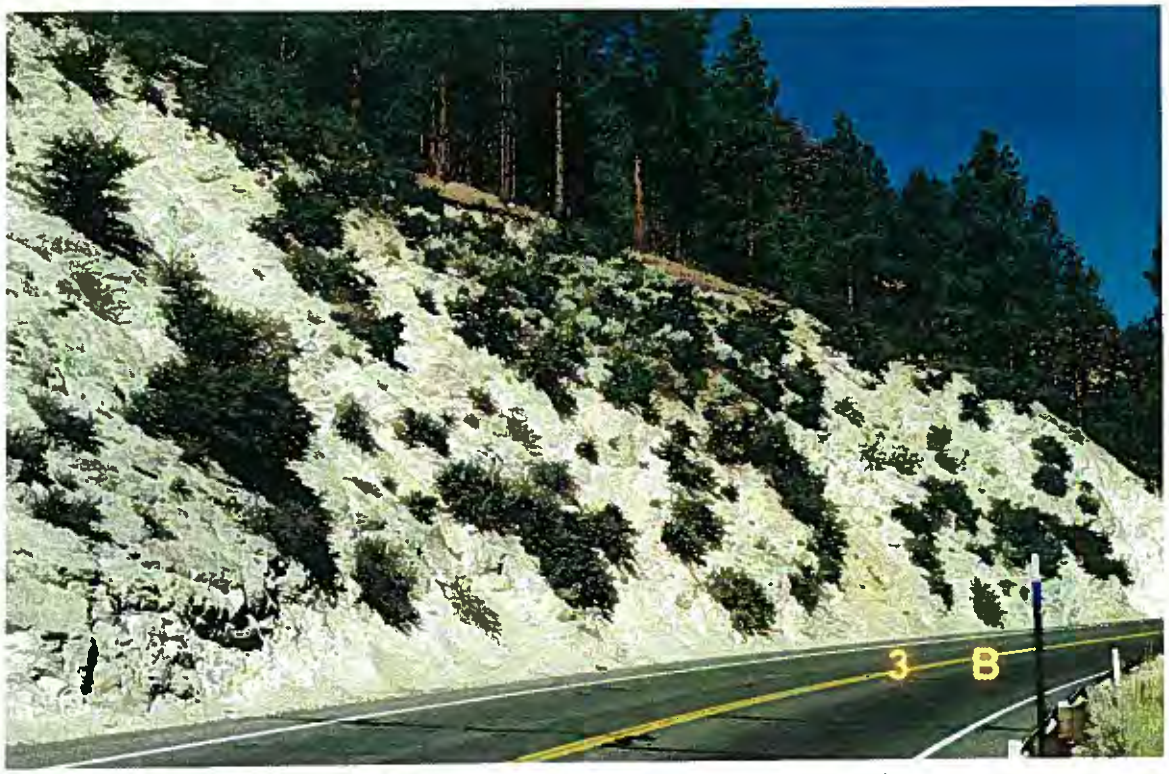


#27 A (Minden side)



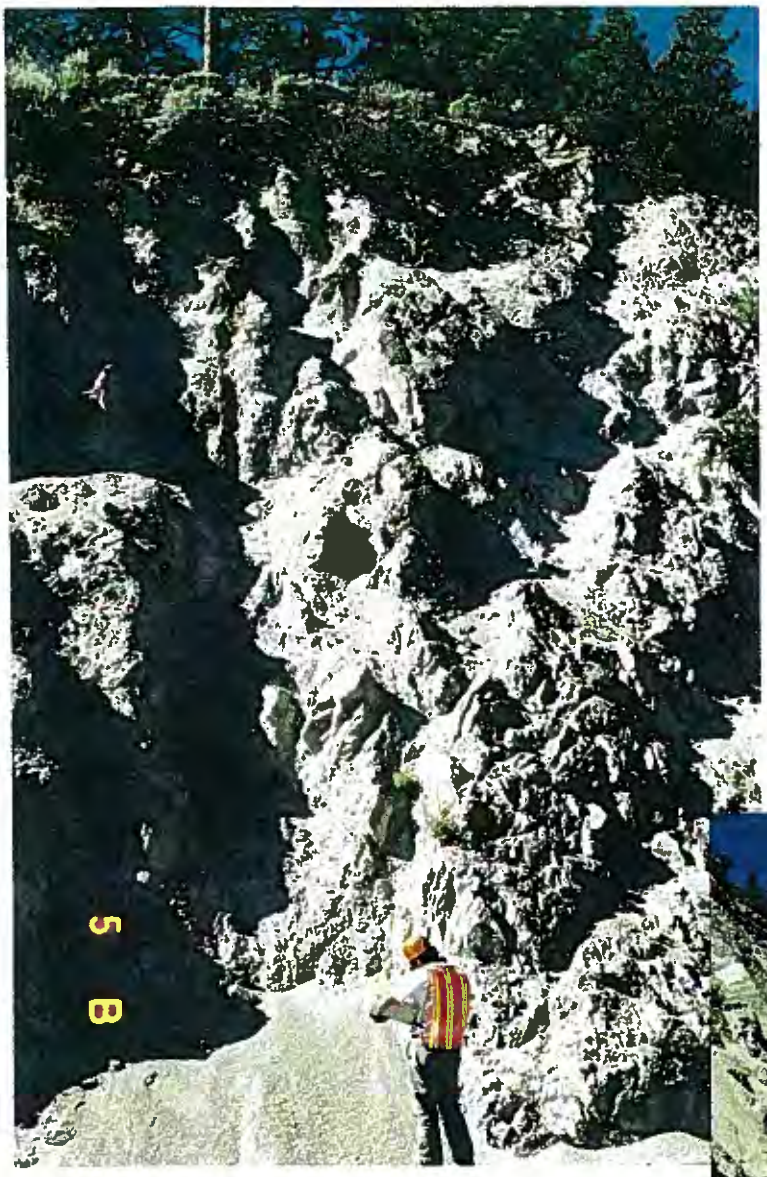
#1B (Minden side)

#2B

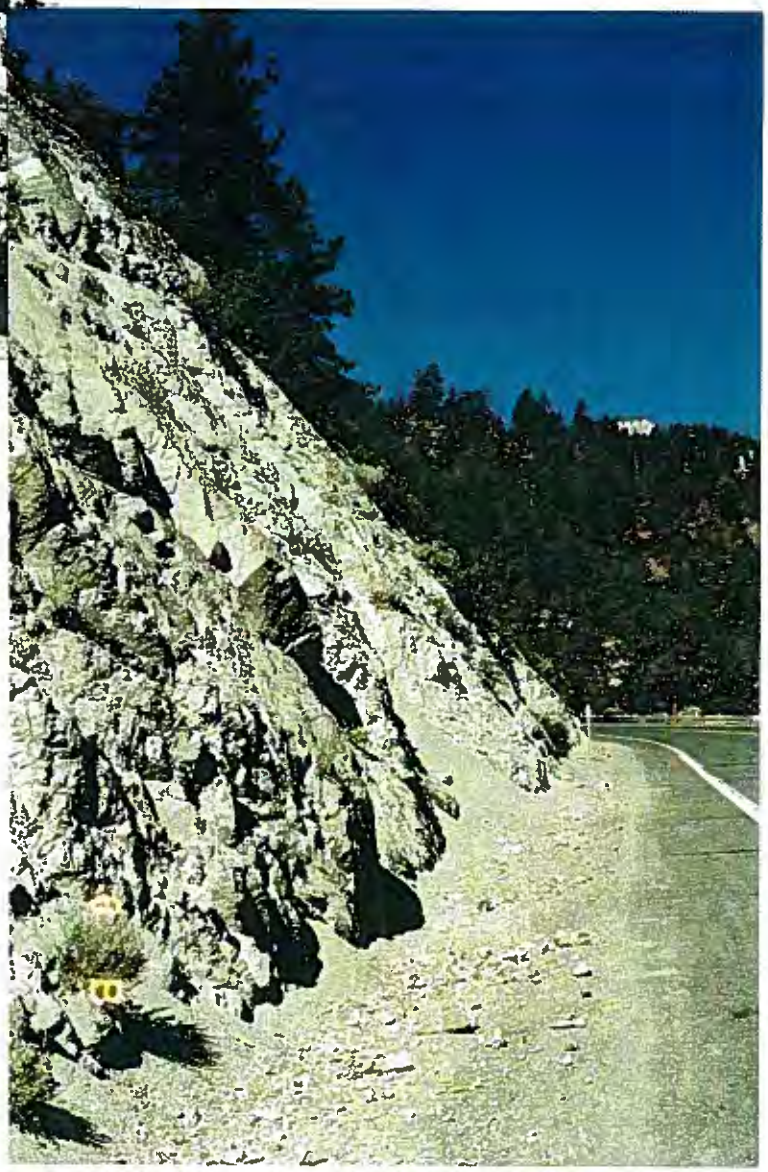


#3B (Minden side)

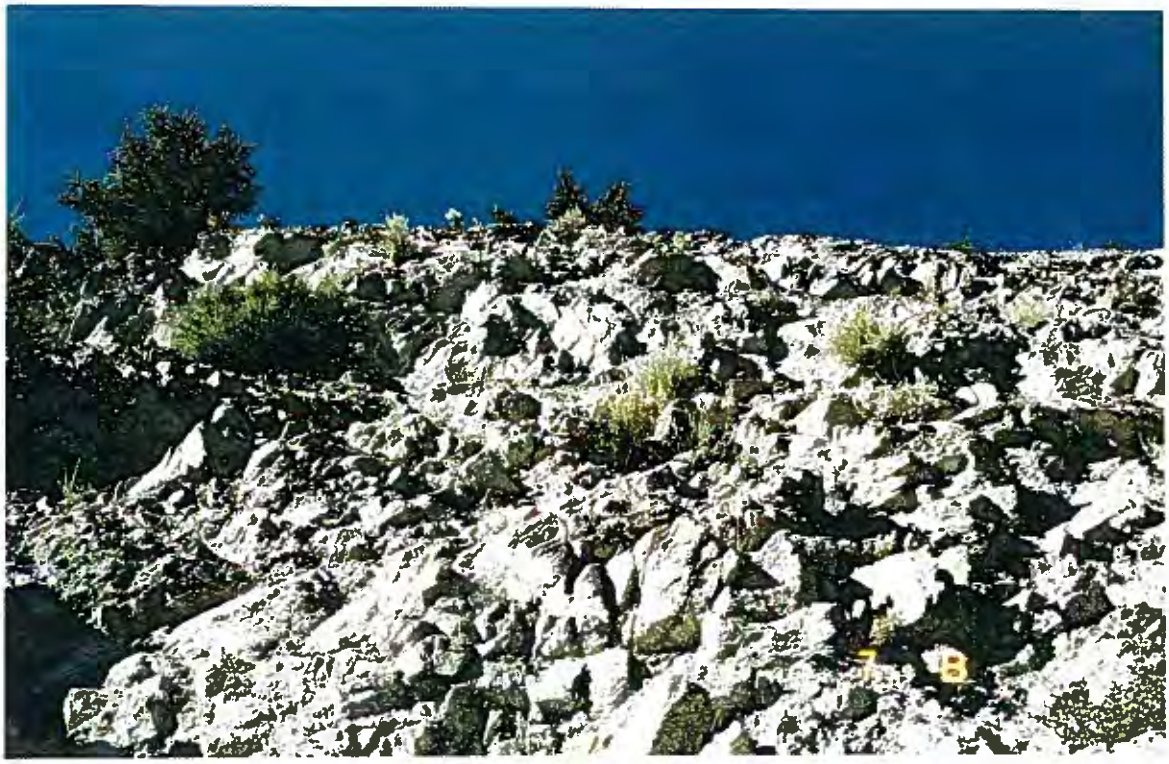
#4B



#5B (Minden side)



#6B

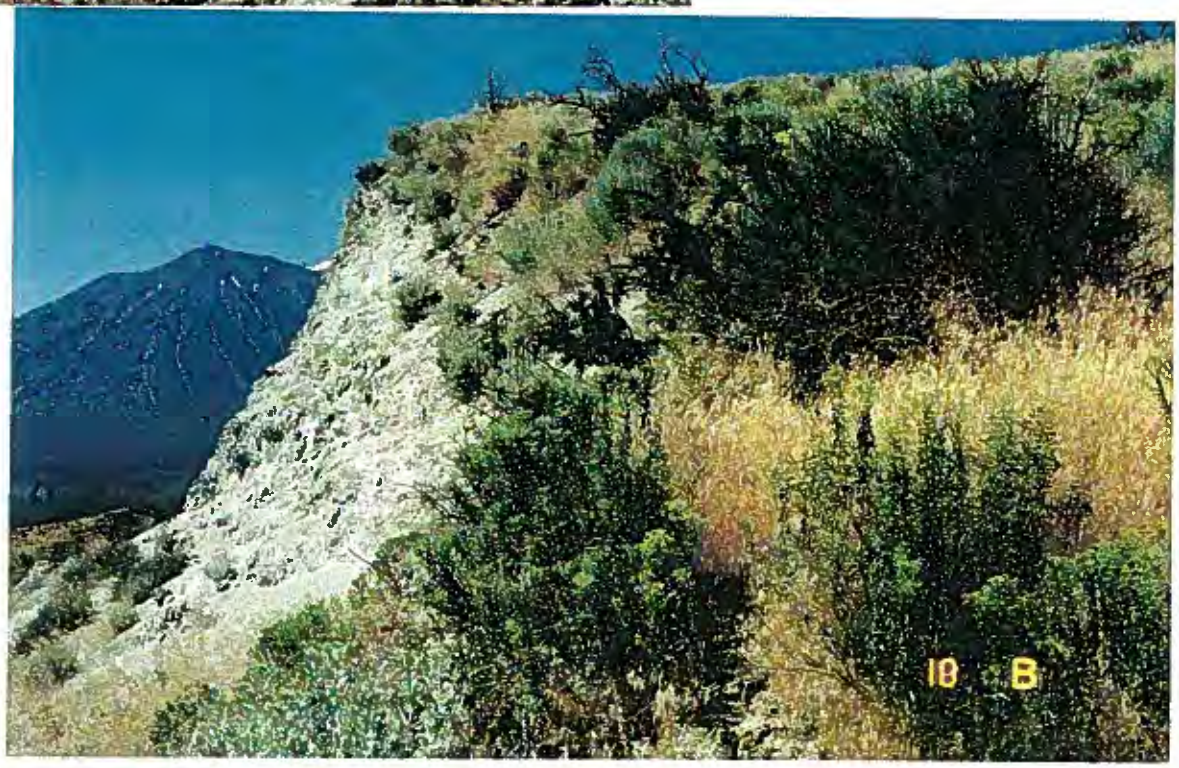


#7B (Minden side)

#8B

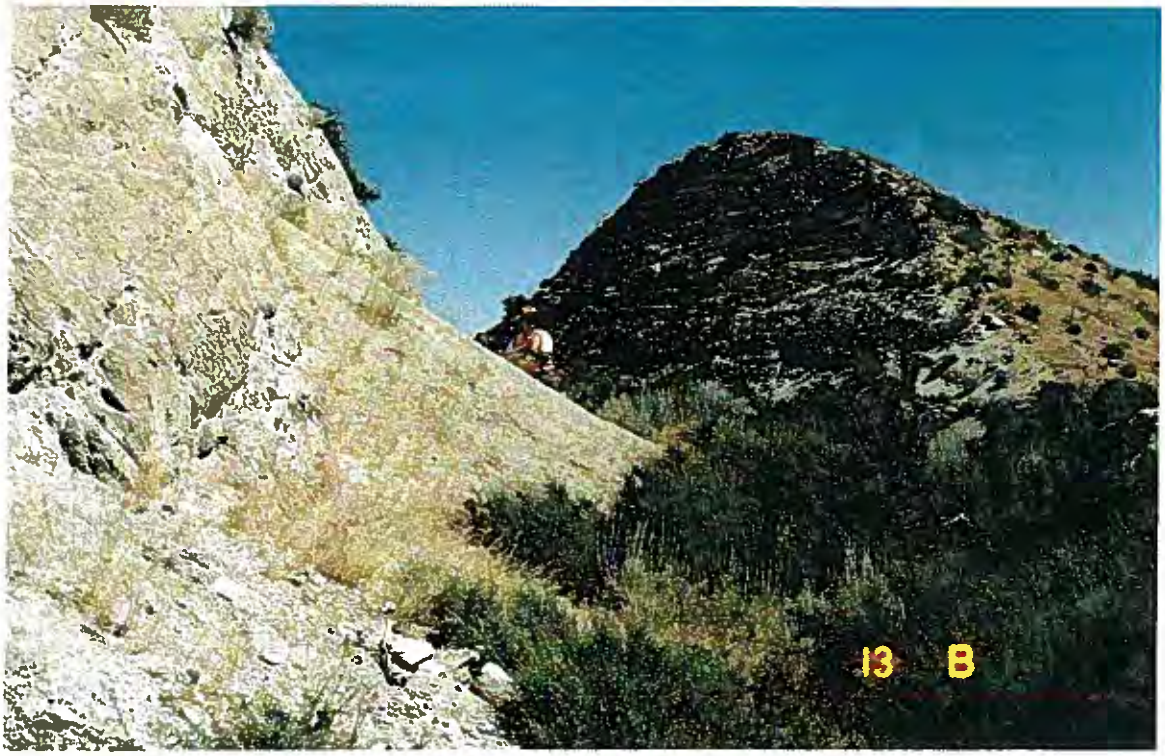
#9B (Minden side)

#10 B

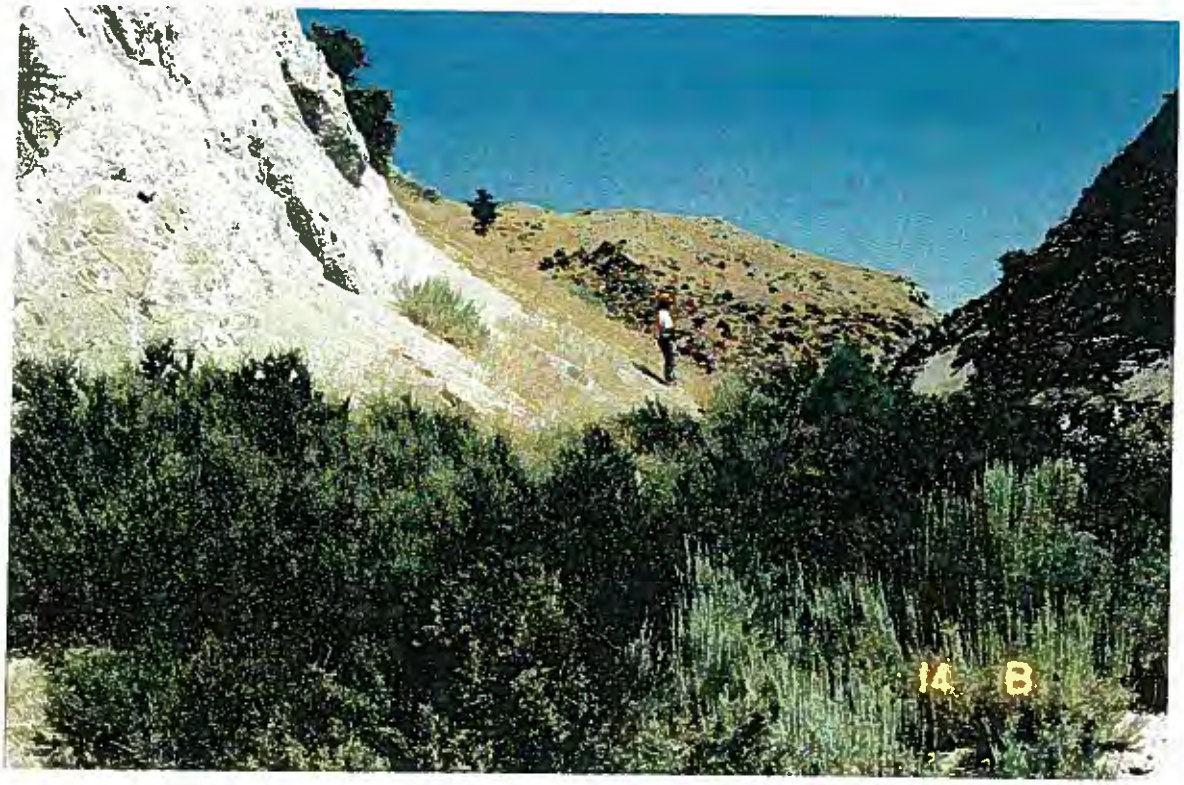


11 B (Minden side)

12 B

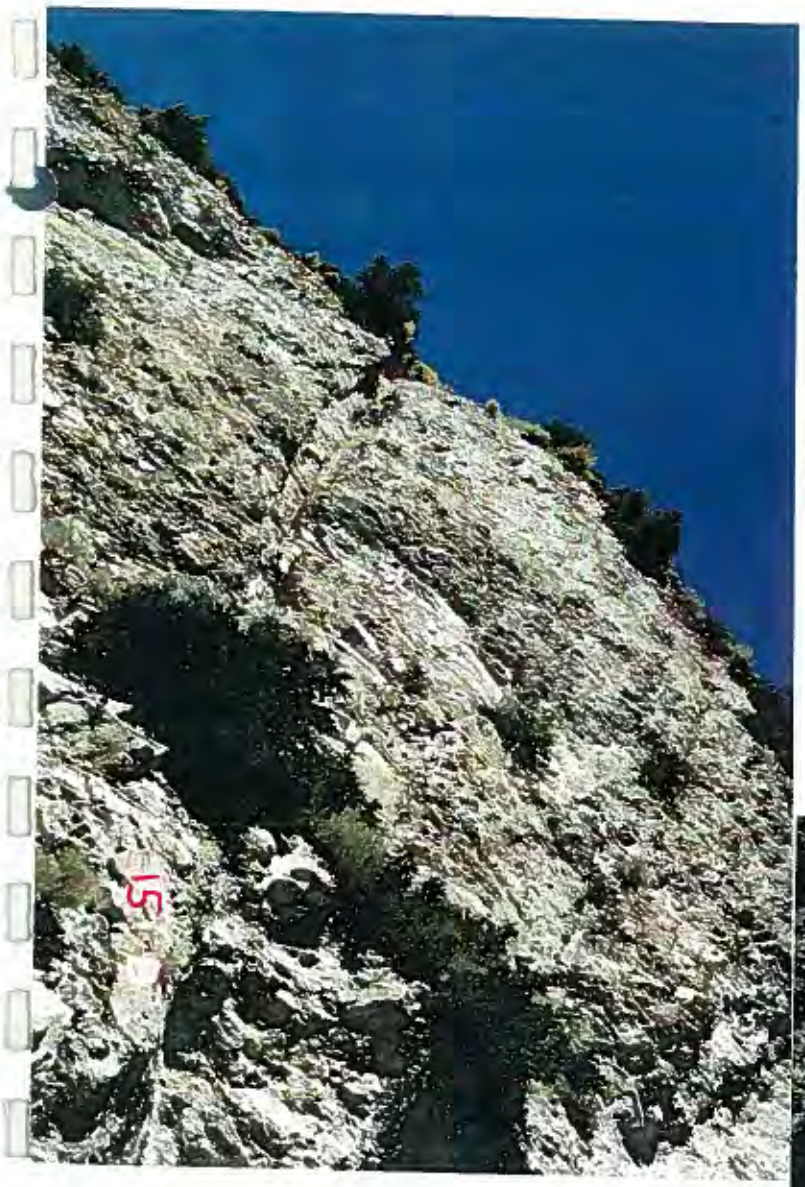


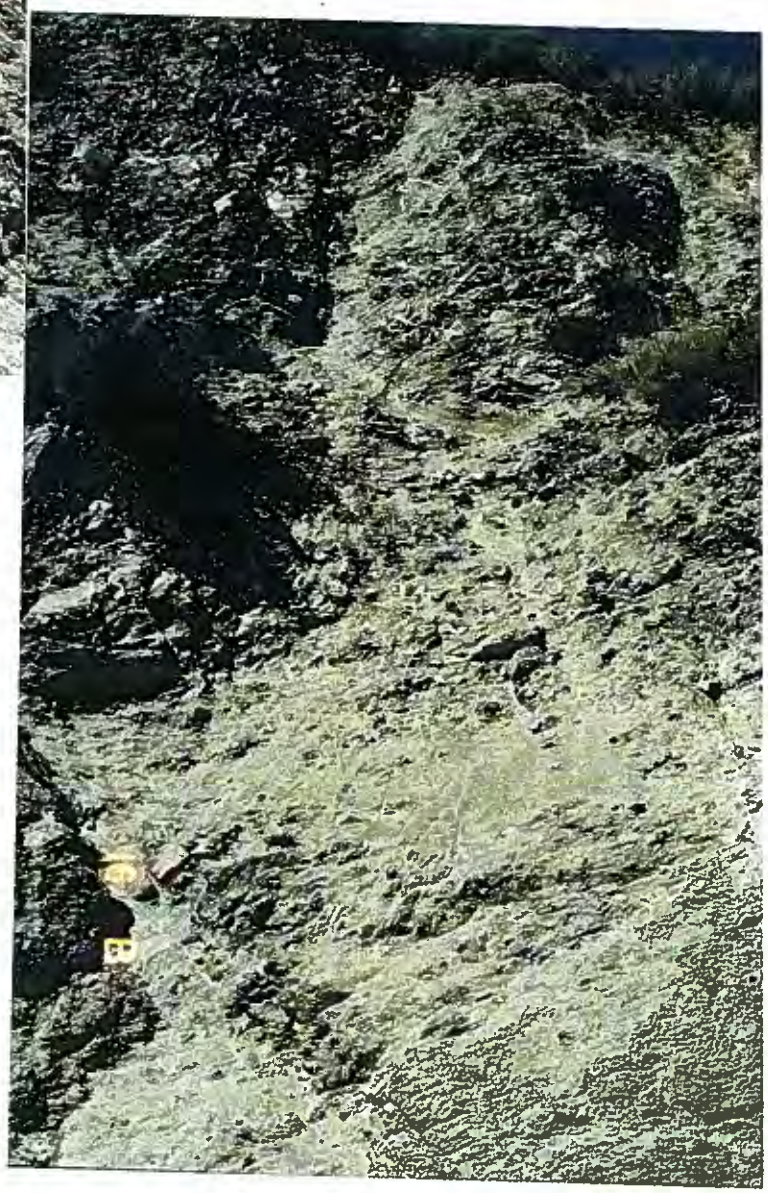
#13 B (Minden side)



14 B

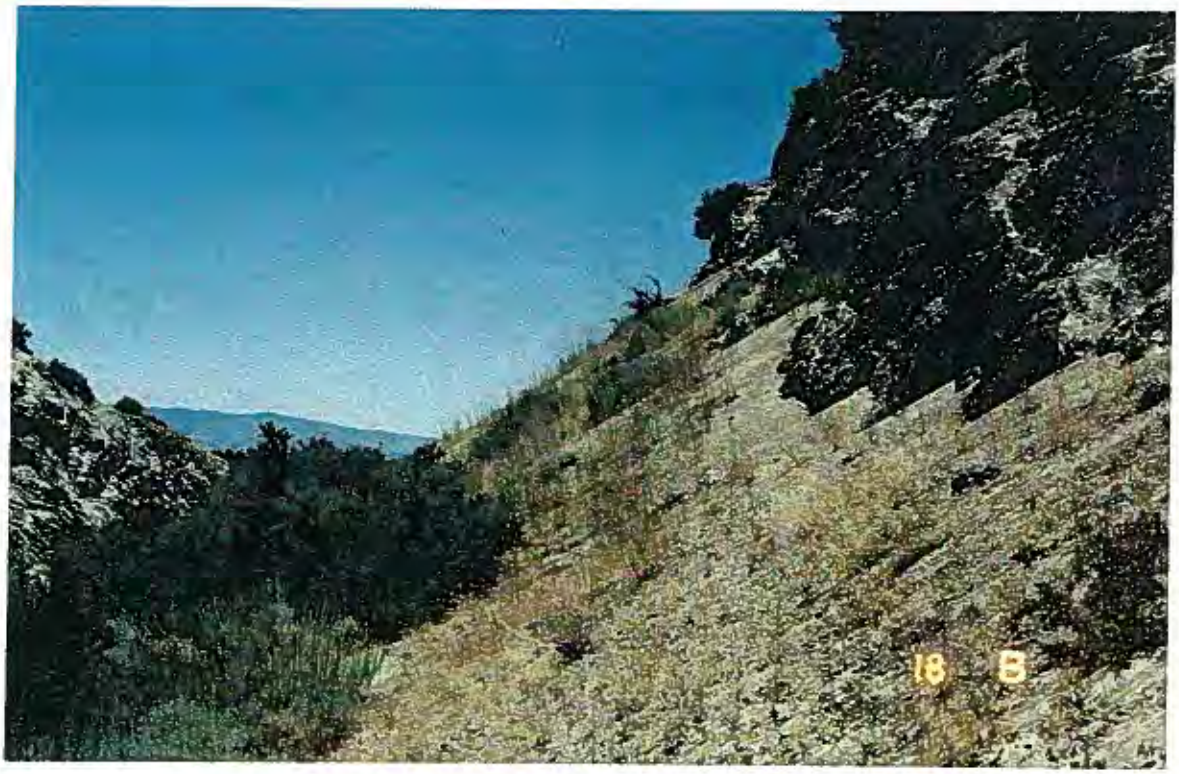
#15B (Minden side)





#16 B

#17B (Minden side)



#18B

#19B (Minden side)

#20 B

#21 B (Minden side)

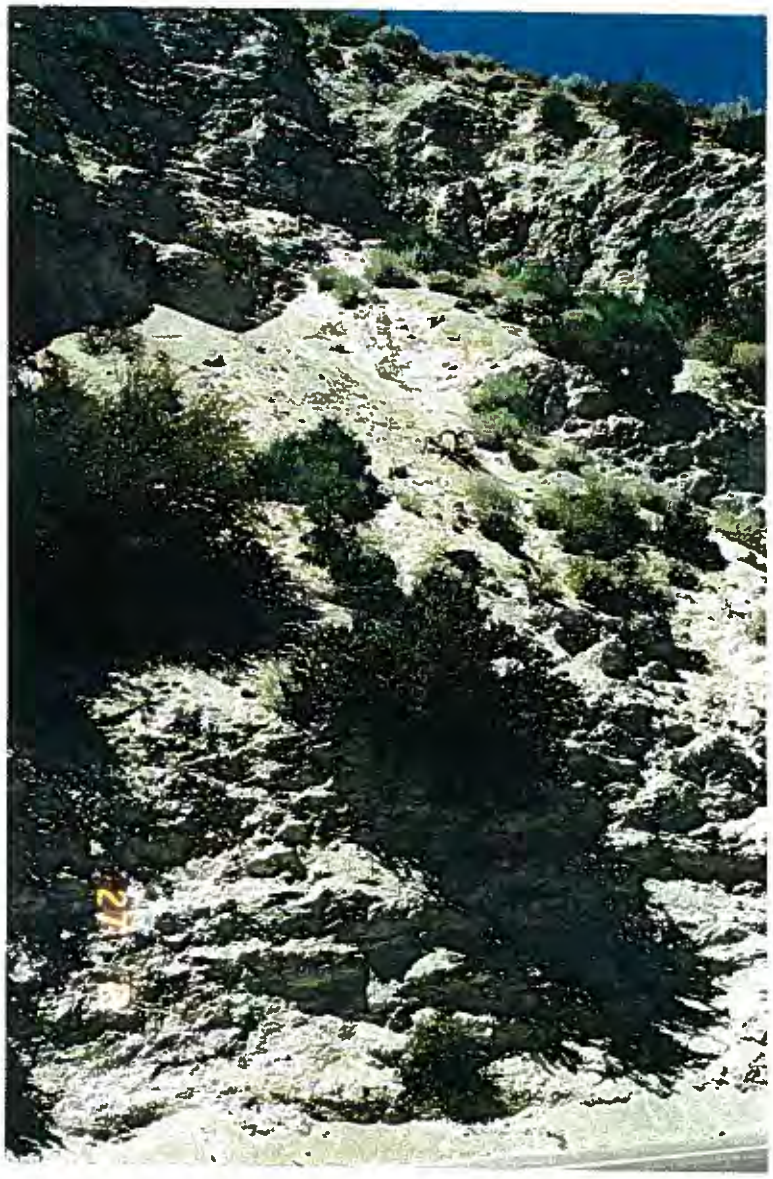
#22 B

#23 B (Minden side)

#24 B

#25 B (Minden side)

26 B



#27 B (Minden side)

#2C (Minden side)

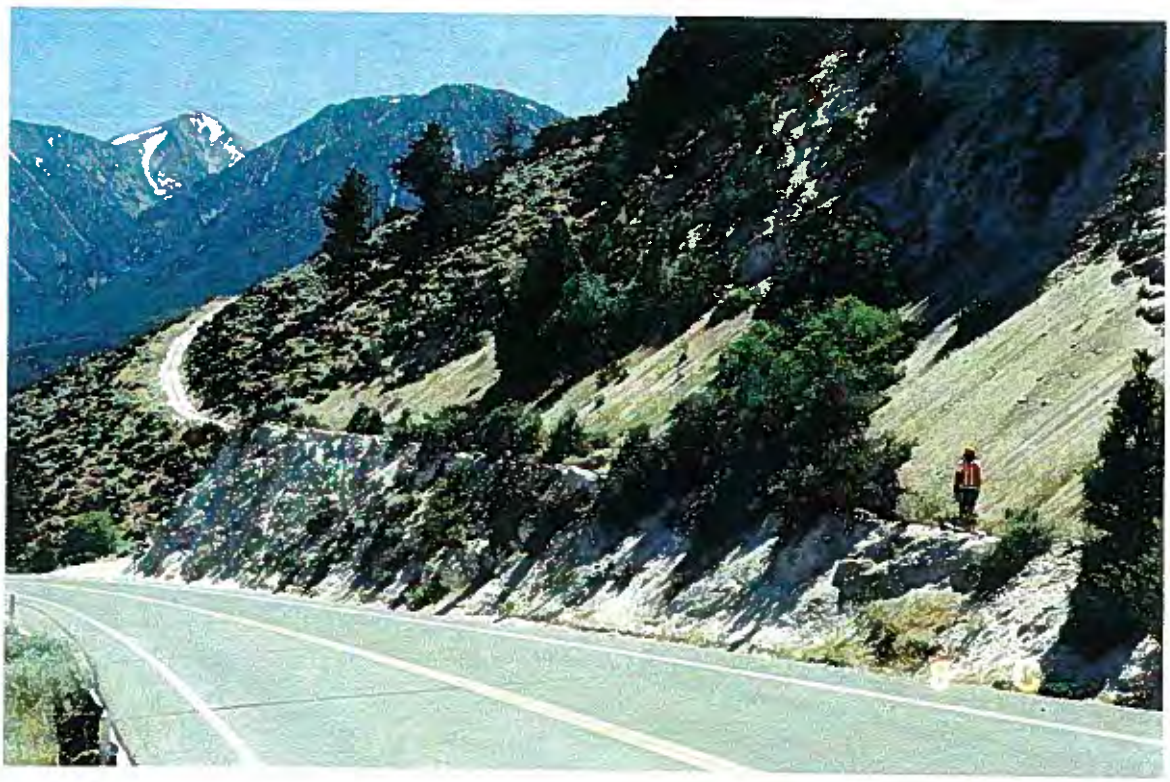
#3C

#4C (Minden side)

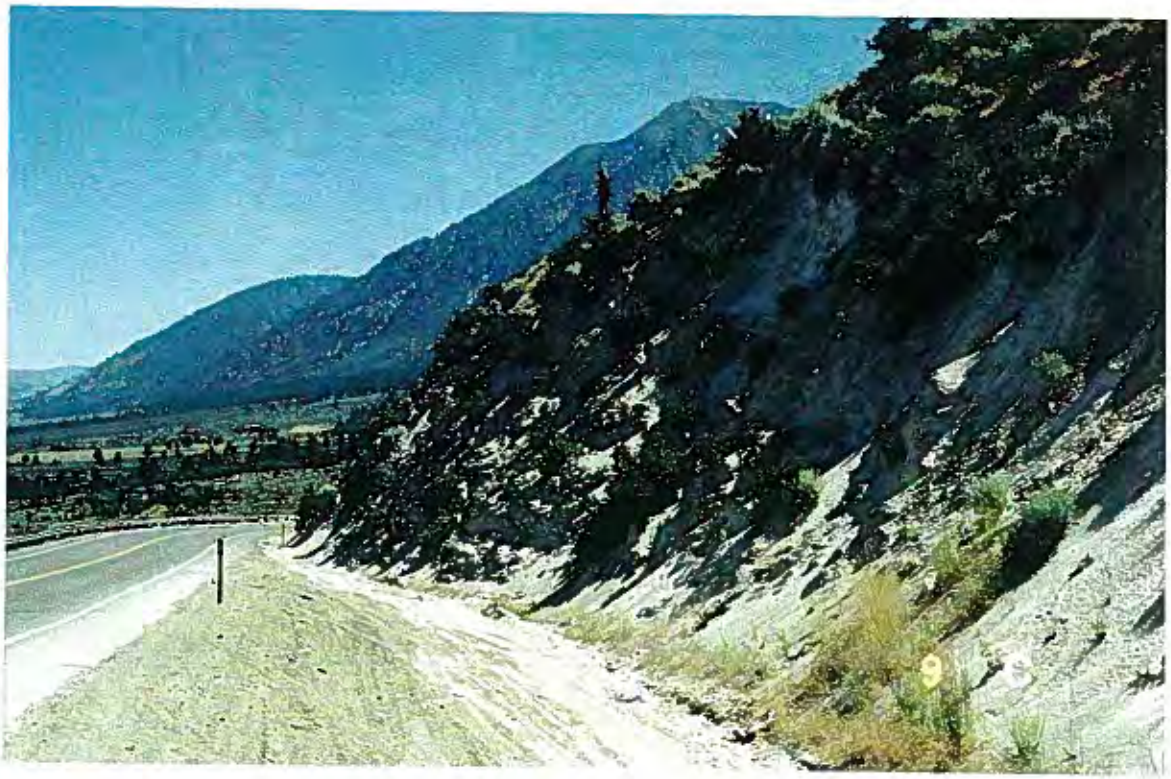
#5C

#6C (Minden side)

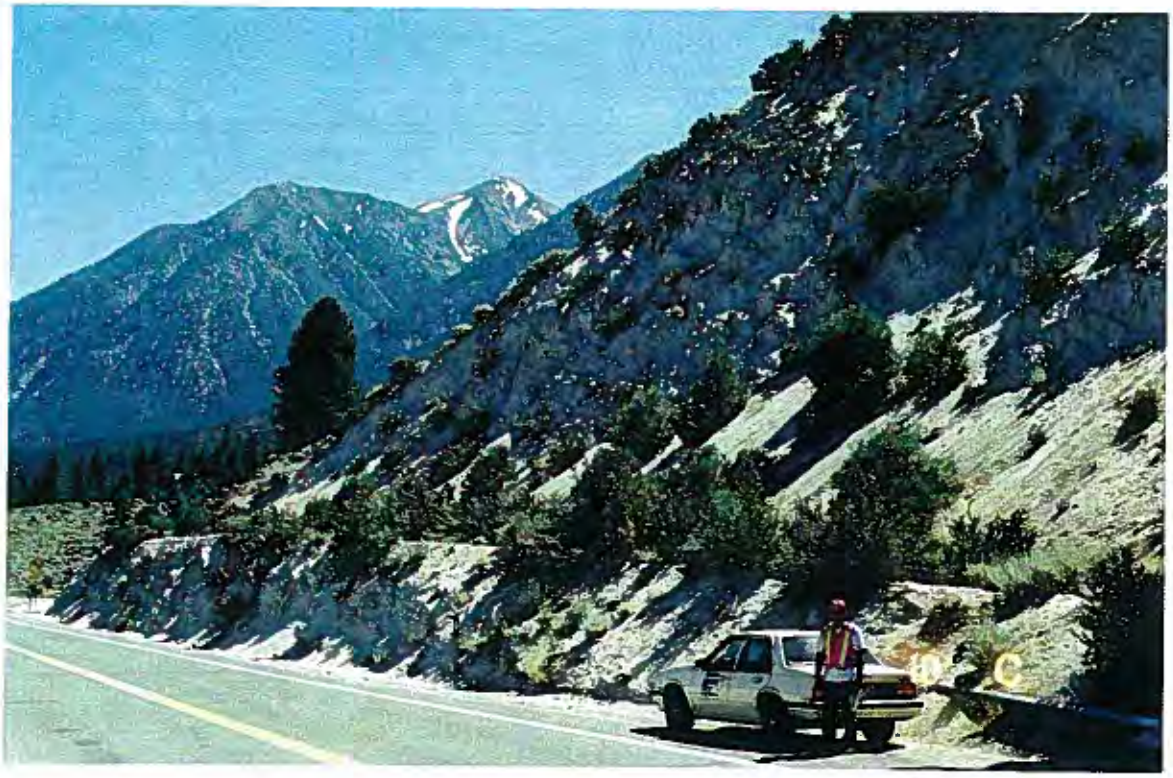
#7C



#8C (Minden side)



#9C



#10C (Minden side)

#11C