U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1955; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG MINERAL AND CEMENT CREEKS IN THE IRONTON QUADRANGLE, ANIMAS RIVER WATERSHED, SAN JUAN COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 1

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked flood plain deposits from gravel mining operations. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

Human works (upper Holocene)—Includes human-caused deposits and structures larger than 10 m in length, such as fluvial mine tailings, ramps, buildings, open pits, and mine waste piles. Structures are either intact or in a state of decay and consist of wooden planks, stone or concrete pads with iron, steel, or aluminum sheets, beams, rebar, wire, and a variety of discarded machinery. Fluvial mine tailings are well sorted and consist of fine-grained sand, silt, and clay-size sediment. Mine waste piles consist of poorly sorted, sand-to boulder-size fragments with a silt matrix; minerals such as pyrite, galena, sphalerite, hematite, jarosite, and goetite are common. The sulfide and oxide minerals impart yellow, orange, and reddish color to these dumps. Human works were constructed between 1870 and the present. Natural processes such as snow avalanches, local flooding, and slope failure aided in the modification and destruction of historic human works. Some human works such as adits and mine dumps are point sources for acidic waters, which discharge elements such as Al, Fe, Cu, Zn, As, and Pb to streams

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2–10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Old valley deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes, including periodic floods, small debris flows, and slope wash. Same as valley deposits (vd) in mode of formation except unit ovd occupies older concave surfaces now perched above the modern valley floor. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

Iron bog deposits (Holocene)—Similar to bog deposits (b), but with high concentrations of iron oxides and other metal oxides that are associated with thiobacilli and other metal-loving bacteria (Spratt and others, 1999). Presence of metals indicates that deposits can act as cation sinks and, when metal saturated, mark the source of acidic waters and waters with low dissolved oxygen content (Stan Church, written commun., 2001). Thickness 1–5 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 15–25 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

BEDROCK

Bedrock (Tertiary)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists mainly of intermediate-composition, volcaniclastic sedimentary rocks, mudflow deposits, and lava flows. Ages of igneous and volcaniclastic rocks range from 35 to 27 Ma. Dacitic to rhyolitic intrusions (about 22 Ma) are preserved in tributary basins centered near Red Mountain Nos. 1 and 3 (Steven and others, 1974; Yager and Bove, 2002)

Contact

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1955; photorevised 1975
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE HANDIES PEAK QUADRANGLE, ANIMAS RIVER WATERSHED, SAN JUAN COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 2

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

Human works (upper Holocene)—Includes human-caused deposits and structures larger than 10 m in length, such as fluvial mine tailings, ramps, buildings, open pits, and mine waste piles. Structures are either intact or in a state of decay and consist of wooden planks, stone or concrete pads with iron, steel, or aluminum sheets, beams, rebar, wire, and a variety of discarded machinery. Fluvial mine tailings are well sorted and consist of fine-grained sand, silt, and clay-size sediment. Mine waste piles consist of poorly sorted, sand-to boulder-size fragments with a silt matrix; minerals such as pyrite, galena, sphalerite, hematite, jarosite, and goetite are common. The sulfide and oxide minerals impart yellow, orange, and reddish color to these dumps. Human works were constructed between 1870 and the present. Natural processes such as snow avalanches, local flooding, and slope failure aided in the modification and destruction of historic human works. Some human works such as adits and mine dumps are point sources for acidic waters, which discharge elements such as Al, Fe, Cu, Zn, As, and Pb to streams

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Bedrock and floodplain deposits (Upper Holocene to Precambrian)—See descriptions for bedrock (B) and floodplain deposits (fp)

BEDROCK

Bedrock (Tertiary)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists mainly of silicic tuffs and associated meggabreccia near Picayune Gulch, and intermediate-composition lava flows. Ages of igneous rocks range from about 35 to 27 Ma (Steven and others, 1974; Yager and Bove, 2002)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

Geochemical profile—Sunnyside Mill, flotation era (1918–1930) fluvial tailings below Eureka. Click on roman numeral to view a linked .pdf-file photograph

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

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coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE MIDDLE AND SOUTH FORKS OF MINERAL CREEK IN THE OPHIR QUADRANGLE, ANIMAS RIVER WATERSHED, SAN JUAN COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 3

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly

mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

Bog deposits (Holocene)—Consist of water-saturated, spongy masses of live and decayed vegetation, bacteria, and peat often associated with shallow standing water. Masses of organic matter produce strong reducing and often, anoxic depositional environments. Forms wetland surfaces, often hummocky and stair stepped on gentle hill slopes adjacent to streams or active springs. Commonly found behind beaver dams. Ages range from present to thousands of years (Stan Church, written commun., 2001). Thickness 1–5 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

Landslide deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt to angular boulder-size clasts consisting of lithologies derived from local formations. Includes deposits formed mainly by translational and rotational slope failure stemming from over steepening by fluvial and glacial erosion and weathering. Deposits form lobate, hummocky surfaces along valley sides. In glacial valleys, the larger landslides formed as glacial ice withdrew. Ages of most deposits unknown. Where relative age of adjacent landslide deposits can be differentiated from cross-cutting geometry, the younger segments are designated as ls1 and the older as ls2. Thickness 1–10 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 15–25 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Terrace and bog deposits (upper Holocene)—See descriptions for terrace (t) and bog deposits (b)

Contact—Dashed lines are contacts between geomorphic features in a map unit

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1955; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE MIDDLE AND SOUTH FORKS OF MINERAL CREEK, MINERAL AND CEMENT CREEKS, AND THE ANIMAS RIVER IN THE SILVERTON QUADRANGLE, ANIMAS RIVER WATERSHED, SAN JUAN COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 4

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

Human works (upper Holocene)—Includes human-caused deposits and structures larger than 10 m in length, such as fluvial mine tailings, ramps, buildings, open pits, and mine waste piles. Structures are either intact or in a state of decay and consist of wooden planks, stone or concrete pads with iron, steel, or aluminum sheets, beams, rebar, wire, and a variety of discarded machinery. Fluvial mine tailings are well sorted and consist of fine-grained sand, silt, and clay-size sediment. Mine waste piles consist of poorly sorted, sand-to boulder-size fragments with a silt matrix; minerals such as pyrite, galena, sphalerite, hematite, jarosite, and goetite are common. The sulfide and oxide minerals impart yellow, orange, and reddish color to these dumps. Human works were constructed between 1870 and the present. Natural processes such as snow avalanches, local flooding, and slope failure aided in the modification and destruction of historic human works. Some human works such as adits and mine dumps are point sources for acidic waters, which discharge elements such as Al, Fe, Cu, Zn, As, and Pb to streams

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Old valley deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Same as valley deposits (vd) in mode of formation except unit ovd occupies older concave surfaces now perched above the modern valley floor. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

Bog deposits (Holocene)—Consist of water-saturated, spongy masses of live and decayed vegetation, bacteria, and peat often associated with shallow standing water. Masses of organic matter produce strong reducing and often, anoxic depositional environments. Forms wetland surfaces, often hummocky and stair stepped on gentle hill slopes adjacent to streams or active springs. Commonly found behind beaver dams. Ages range from present to thousands of years (Stan Church, written commun., 2001). Thickness 1–5 m

Iron bog deposits (Holocene)—Similar to bog deposits (b), but with high concentrations of iron oxides and other metal oxides that are associated with thiobacilli and other metal-loving bacteria (Spratt and others, 1999). Presence of metals indicates that deposits can act as cation sinks and, when metal saturated, mark the source of acidic waters and waters with low dissolved oxygen content (Stan Church, written commun., 2001). Thickness 1–5 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

Landslide deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt to angular boulder-size clasts consisting of lithologies derived from local formations. Includes deposits formed mainly by translational and rotational slope failure stemming from over steepening by fluvial and glacial erosion and weathering. Deposits form lobate, hummocky surfaces along valley sides. In glacial valleys, the larger landslides formed as glacial ice withdrew. Ages of most deposits unknown. Where relative age of adjacent landslide deposits can be differentiated from cross cutting geometry, the younger segments are designated as ls1 and the older as ls2. Thickness 1–10 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Fan and glacial till deposits (Holocene to upper Pleistocene)—See descriptions for fan (f) and glacial till deposits (m)

Landslide and glacial till deposits (Holocene to upper Pleistocene)—See descriptions for landslide (ls) and glacial till deposits (m)

Terrace and bog deposits (Holocene to uppermost Pleistocene)—See descriptions for terrace (t) and bog deposits (b)

Bedrock and landslide deposits (Holocene to Precambrian)—See descriptions for bedrock (B) and landslide deposits (ls)

BEDROCK

Bedrock (Tertiary to Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists of Tertiary intermediate composition, lava flows, volcaniclastic sedimentary rocks, mudflow deposits, granitic intrusions, Paleozoic limestone, and Precambrian gneiss and schist below Silverton in the upper Animas Canyon. Ages of igneous and volcaniclastic rocks range from 35 to 27 Ma (Steven and others, 1974; Yager and Bove, 2002)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Water

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

Geochemical profile—Mineral Creek terrace, circa 1750–1800 A.D. Click on roman numeral to view a linked .pdf-file photograph and related geochemical profile

Geochemical profile—Cement Creek, pre-mining terrace. Click on roman numeral to view a linked .pdf-file photograph and related geochemical profile

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1955; photorevised 1975
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER AND CUNNINGHAM CREEK IN THE HOWARDSVILLE QUADRANGLE, ANIMAS RIVER WATERSHED, SAN JUAN COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 5

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

Human works (upper Holocene)—Includes human-caused deposits and structures larger than 10 m in length, such as fluvial mine tailings, ramps, buildings, open pits, and mine waste piles. Structures are either intact or in a state of decay and consist of wooden planks, stone or concrete pads with iron, steel, or aluminum sheets, beams, rebar, wire, and a variety of discarded machinery. Fluvial mine tailings are well sorted and consist of fine-grained sand, silt, and clay-size sediment. Mine waste piles consist of poorly sorted, sand-to boulder-size fragments with a silt matrix; minerals such as pyrite, galena, sphalerite, hematite, jarosite, and goetite are common. The sulfide and oxide minerals impart yellow, orange, and reddish color to these dumps. Human works were constructed between 1870 and the present. Natural processes such as snow avalanches, local flooding, and slope failure aided in the modification and destruction of historic human works. Some human works such as adits and mine dumps are point sources for acidic waters, which discharge elements such as Al, Fe, Cu, Zn, As, and Pb to streams

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

BEDROCK

Bedrock (Tertiary to Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists of Tertiary intermediate-composition lava flows, volcaniclastic sedimentary rocks, mudflow deposits, granitic intrusions, and Precambrian gneiss and schist in the headwaters of Cunningham Creek. The age of most igneous and volcaniclastic rocks is about 27 Ma (Steven and others, 1974; Yager and Bove, 2002)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

Geochemical profile—Pre-mining silts; Eureka to Maggie Gulch reach. Click on the roman numeral to view a linked .pdf-file photograph and related geochemical profile

Geochemical profile—Circa 1885 terrace sediments. Click on the roman numeral to view a linked .pdf-file photograph and related geochemical profile

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1964; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE SNOWDON PEAK QUADRANGLE, ANIMAS RIVER WATERSHED, LA PLATA AND SAN JUAN COUNTIES, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 6

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indictate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly

mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Old valley deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Same as valley deposits (vd) in mode of formation except unit ovd occupies older concave surfaces now perched above the modern valley floor. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Terrace and glacial till deposits (Holocene to upper Pleistocene)—See descriptions for terrace (t) and glacial till deposits (m)

BEDROCK

Bedrock (Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists of Precambrian gneiss, schist, quartzite, and granite (Steven and others, 1974)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

Geochemical profile—Abandoned channel at Elk Park. Click on the roman numeral to view a linked .pdf-file photograph and related geochemical profile

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1963; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE ELECTRA LAKE QUADRANGLE, ANIMAS RIVER WATERSHED, LA PLATA COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999.

DIGITAL DATA SERIES 71
PLATE 7

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly

mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Glacial till and colluvium (upper Pleistocene to uppermost Holocene)—See descriptions for glacial till (m) and colluvial deposits (c)

Fan and terrace deposits (Holocene)—See descriptions for fan (f) and terrace deposits (t)

BEDROCK

Bedrock (lower Paleozoic to Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists of Precambrian schist, gneiss, and gabbro (Steven and others, 1974)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1973; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE MOUNTAIN VIEW CREST QUADRANGLE, ANIMAS RIVER WATERSHED, LA PLATA COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 8

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Uncolored boxes denote units not mapped on this plate]

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events.

Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

Debris cone deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted silt, sand, and gravel with angular cobbles and boulders derived from source gullies. Fluvial and colluvial processes predominate. Deposit volume increases through time due to freeze-thaw weathering processes. Seasonal thunderstorm events result in rock falls, debris flows, and sheet wash onto the cone. Debris cones are fan shaped in map view, have slopes greater than 20°, and are found at the mouth of steep bedrock gullies. Growth has been continuous since glacial retreat. Thickness 1–10 m

Talus deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted, angular, cobble-size stones and blocks derived from rock falls above the talus field. Deposits blanket topography on steep valley slopes at the angle of repose (33°–35°). Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

BEDROCK

Bedrock (Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists mainly of Precambrian gneiss and schist (Steven and others, 1974)

Contact—Dashed lines are contacts between geomorphic features in a map unit

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1963; photorevised 1979
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE HERMOSA QUADRANGLE, ANIMAS RIVER WATERSHED, LA PLATA COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999

DIGITAL DATA SERIES 71
PLATE 9

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

Human works (upper Holocene)—Includes human-caused deposits and structures larger than 10 m in length, such as fluvial mine tailings, ramps, buildings, open pits, and mine waste piles. Structures are either intact or in a state of decay and consist of wooden planks, stone or concrete pads with iron, steel, or aluminum sheets, beams, rebar, wire, and a variety of discarded machinery. Fluvial mine tailings are well sorted and consist of fine-grained sand, silt, and clay-size sediment. Mine waste piles consist of poorly sorted, sand- to boulder-size fragments with a silt matrix; minerals such as pyrite, galena, sphalerite, hematite, jarosite, and goetite are common. The sulfide and oxide minerals impart yellow, orange, and reddish color to these dumps. Human works were constructed between 1870 and the present. Natural processes such as snow avalanches, local flooding, and slope failure aided in the modification and destruction of historic human works. Some human works such as adits and mine dumps are point sources for acidic waters, which discharge elements such as Al, Fe, Cu, Zn, As, and Pb to streams

ALLUVIAL DEPOSITS

Floodplain deposits (upper Holocene)—Unconsolidated sand and gravel, commonly with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper Animas River watershed. Deposited in active stream channels and as overbank sediment on adjacent terraces less than 1 m above channel. Mostly deposited during spring floods and storm discharge events. Natural, fluvial processes throughout the watershed and, in places, human activities, such as between Eureka and Howardsville, have reworked many floodplain deposits since 1860. Red (iron oxide), white (aluminum hydroxide), and black (manganese oxide) staining of floodplain sediments in some reaches indicates high concentrations of dissolved metals. Thickness 1–10 m

Terrace deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with silt matrix; poorly sorted, subround to round gravels, commonly imbricated; boulders as much as 0.5 m in diameter common in upper watershed reaches. In highly mineralized drainages, iron-oxide cements form ferricrete (iron-cemented conglomerate). Sediment is deposited during spring runoff and storm over-bank flow discharge events. Surfaces are narrow and flat, and parallel the modern stream channel. Where differentiated by their relative ages, youngest terraces are labeled t1, lie 1–2 m above the modern channel, and predate 1860 (Kirk Vincent, U.S. Geological Survey, written commun., 2001). Sequentially higher and older terraces are designated t2, t3, and t4. Higher terraces display stronger color and textural B soil horizons. Terrace height above the stream channel varies from 2 to 10 m. Terraces in the headwater regions of the Animas River watershed are not necessarily correlative with terraces in the lower Animas River basin. Thickness 1–10 m

Valley deposits (upper Holocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Deposits often found on slightly concave valley floors near the heads of tributaries where no distinct fluvial terraces or alluvial fans can be found. Deposits are both historic and pre-historic in age. Thickness 1–5 m

Old valley deposits (Holocene to uppermost Pleistocene)—Unconsolidated sand and gravel with a silty matrix and occasionally larger stones derived from valley sides. Deposits formed by fluvial and colluvial processes including periodic floods, small debris flows, and slope wash. Same as valley deposits (vd) in mode of formation except unit ovd occupies older concave surfaces now perched above the modern valley floor. Thickness 1–5 m

Oxbow deposits (Holocene)—Unconsolidated silt and sand, mixed with peat near the surface; discontinuous gravel lenses preserved at depth. Deposits occupy abandoned meanders that become oxbow lakes when flooded. Found in lower Animas Valley. Deposits are both historical and pre-historical in age. Older oxbow deposits commonly have thicker soil and peat horizons at the surface and eventually are filled with silt to become dry swales on the floodplain surface. Thickness 1–10 m

Alluvial fan deposits (Holocene to uppermost Pleistocene)—Unconsolidated, poorly sorted sand and gravel with silt matrix; cobbles and boulders common. Sediment supplied episodically to fan surfaces by streams and debris flows along confined, commonly braided channels from seasonal storm runoff events. Form as fan-shaped deposits (in map view) at mouths of streams where stream gradient and velocity decreases and where topography widens from confined channels to open valleys. Surface gradients are less than 20°. Fan development post-dates glaciation and therefore their growth was initiated after 15 ka. Where the relative fan age can be differentiated from cross-cutting geometry, the younger fan segments are designated as f1 and the older as f2 and f3. Thickness 1–20 m

COLLUVIAL DEPOSITS

Colluvial deposits (upper Holocene to uppermost Pleistocene)—Unconsolidated soil and sand- to cobble-size debris derived from valley walls. Processes include rockfall, sheetwash, and creep. Colluvium is discontinuous on the valley sides and produces irregular-shaped, hummocky surfaces. Growth has been continuous since glacial retreat. Thickness 1–5 m

GLACIAL DEPOSITS

Glacial till deposits (upper Pleistocene)—Unconsolidated to compacted, poorly sorted, clay- to boulder-size sediment derived from ablation of glaciers at ice margins. Form hummocky end and lateral moraine ridges. Best displayed at north end of Durango and near Silverton. Deposits represent the last vestiges of glaciers between 12 and 15 ka. Carrara and others (1984) and Maher (1972) indicated ice-free conditions existed as early as 15 ka, but recent data indicate ice-free conditions at around 12 ka (Gillam, 1998). Till deposits north of Durango are subdivided into two relative ages. Animas City moraines (ma) are 12–35 ka and Spring Creek moraines (ms) are 85–160 ka (Gillam, 1998; Carroll and others, 1999). Thickness 1–20 m

UNDIFFERENTIATED DEPOSITS

Colluvium and old valley deposits (upper Holocene to uppermost Pleistocene)—See descriptions for colluvium (c) and old valley deposits (ovd)

Bedrock and colluvial deposits (upper Holocene to Precambrian)—See descriptions for bedrock (B) and colluvial deposits (c)

Bedrock and glacial till deposits (upper Pleistocene to Precambrian)—See descriptions for bedrock (B) and glacial till deposits (m)

BEDROCK

Travertine deposits (Upper Holocene to Upper Pleistocene)—Vuggy, thinly laminated calcareous tufa. Calcium carbonate deposited from super-saturated thermal spring waters associated with algae growth to produce pores and cavities. Deposits form tufa mounds along valley sides. Thermal springs are associated with fractured bedrock in lower Animas Valley. Water temperatures range from 32° to 44° Celsius (Barrett and Pearl, 1976). Growth has been continuous since last glacial retreat

Bedrock (upper Paleozoic to Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists mainly of Paleozoic conglomerate, sandstone, shale, siltstone, mudstone, and limestone. Precambrian granite exposed at type locality of Bakers Bridge (Steven and others, 1974)

Contact—Dashed lines are contacts between geomorphic features in a map unit

Lake

Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY

Base from U.S. Geological Survey, 1963; photorevised 1978
Projection: Universal Transverse Mercator, zone 13.
10,000-foot grid based on Colorado
coordinate system, south zone.
1927 North American datum

SCALE 1:24 000

CONTOUR INTERVAL 40 FEET

SURFICIAL GEOLOGY ALONG THE ANIMAS RIVER IN THE DURANGO EAST QUADRANGLE, ANIMAS RIVER WATERSHED, LA PLATA COUNTY, COLORADO

By
Robert W. Blair, Jr., and Douglas B. Yager
2002

Geology mapped by Blair, 1998–1999.
Digitally compiled by Yager, 1998–1999.

DIGITAL DATA SERIES 71
PLATE 10

DESCRIPTION OF MAP UNITS

[Unit descriptions do not differ between plates 1 through 10 with the exception of bedrock, which does differ based on lithologies and geologic formations represented in a mapped area. Prefix "r" indicates alluvial, colluvial, or glacial deposits disturbed by human activities. For example, rfp refers to reworked floodplain deposits from gravel mining operations. Unit symbols separated by a slash indicate that two units are preserved in mapped area; color in box denotes predominant unit. Uncolored boxes denote units not mapped on this plate]

HUMAN-RELATED DEPOSITS AND STRUCTURES

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UNDIFFERENTIATED DEPOSITS

Colluvium and glacial till deposits (upper Holocene to upper Pleistocene)—See descriptions for colluvium (c) and glacial till deposits (m)

Bedrock and colluvial deposits (upper Holocene to Precambrian)—See descriptions for bedrock (B) and colluvial deposits (c)

BEDROCK

Bedrock (upper Mesozoic to Precambrian)—Bedrock forms the exposed valley walls and occasional knobs on the valley floor with thin to no soil cover. Where soil cover is thin, vegetation cover may be present. Bedrock consists mainly of Paleozoic to Mesozoic conglomerate, sandstone, shale, siltstone, mudstone, and limestone. Precambrian granite exposed at type locality of Bakers Bridge (Steven and others, 1974)

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Site of photograph—Camera symbol is located where photograph was taken and camera symbol lens is approximately oriented in direction of photograph. Click on each photograph icon to view a linked .pdf-file photograph and site description

Geochemical profile—Animas River oxbow deposit. Click on roman numeral to view a linked .pdf-file of a related geochemical profile