DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

Preliminary Data Report conducted for the Colorado State Geological Survey on the Superconducting, Supercollider Study

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INTRODUCTION

This report documents the geological and geotechnical data acquired from one drill hole that is part of Colorado's SSC (Superconducting Supercollider) site study initiated to consider the Cretacous Pierre Shale as a host material for the SSC facility. Upon request from the CSGS (Colorado State Geological Survey), the USGS (U.S. Geological Survey) participated in this study by gathering and compiling geologic and geotechnical data from core retrieved from CSGS drill hole 10.

The drill site, ground elevation 4,750 ft, is located in the NW1/4, Sec. 17, R. 57 w., T. 2 S. (U.S. Geological Survey, 1976), near Last Chance, Colorado (fig. 1.), 75 mi east of Denver, Colorado. In March 1986, drilling began in soil and penetrated and reached total depth within the Pierre Shale (Late Cretaceous age).

FIELD AND EXPERIMENTAL PROCEDURES

The hole was drilled and core was recovered by using a truck-mounted mobile B-80 auger/core drill. The first 20 ft from the surface were augered with a 4-in.-outside-diameter auger pipe that was left in the hole and used as surface casing for coring. At a depth of 20 ft, when the hardness of the formational material exceeded 50 blows per foot by a 140-lb hammer through a 30-in. drop on a California sampler, the material was sufficiently hard to core. A Christensen NX-size wire-line with a split inner barrel and tungsten-carbide bit was used to advance the hole to a total depth of 277 ft. Core samples, having an average diameter of 1.78 in., were obtained with split-tube inner core barrels as much as 10 ft in length. Core recovery was greater than 95 percent. The hole was advanced using only water as the circulating drill fluid.

In the field, the core was removed from the split inner barrel of the core barrel, logged, and tested for carbonate content with 10 percent solution of HCL. Concurrently, a rock-color chart (Rock-color chart committee, 1975) was used for core-color description. After logging, selected core samples were used for as-received bulk density tests and moisture content determinations. Three as-received bulk densities were determined for each sample in a manner described by Chleborad and others (1975), with the following exception: the samples were not oven dried prior to waxing. Similarly, to determine moisture content, three subsamples for each selected sample were weighed and placed in preweighed tins immediately after logging. These samples were later transported to the USGS Laboratory in Denver, Colorado, where they were oven dried for 24 hrs at a constant temperature of 110 ^{o}C and reweighed.

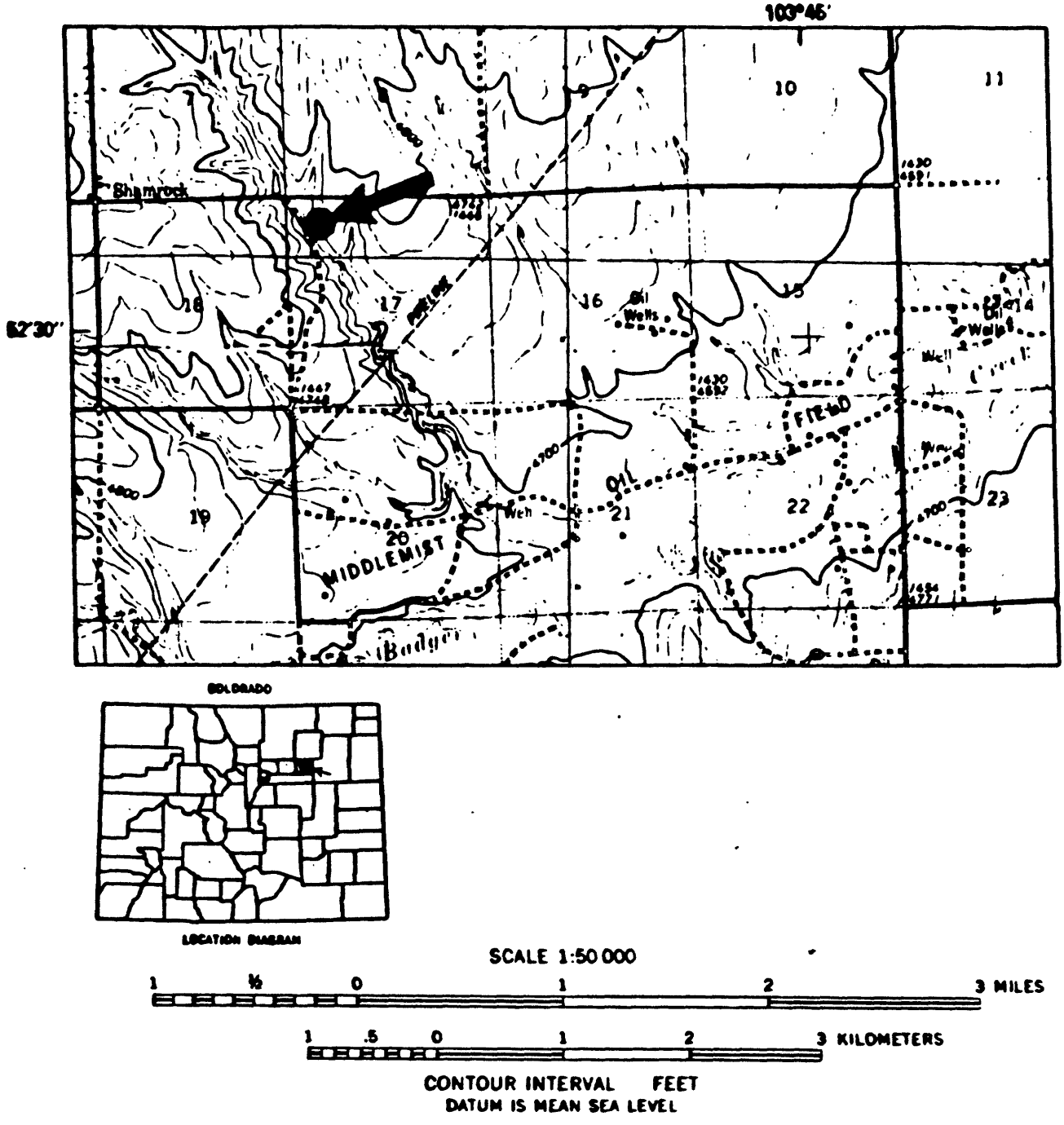

Figure 1. Location of CSGS drill hole 10 (dot and arrow).

SUMMARY OF THE PRINCIPAL ROCK TYPES AND THEIR GEOTECHNICAL CHARACTERISTICS

Table 1 summarizes the lithology, natural fractures, and geotechnical properties measured on selected core samples. The average value for each set of three samples is presented in table 1 for both the as-received bulk density and the moisture content.

The upper 20 ft of the section consist of weak surficial materials and weathered shale that were sampled by auger (Mark Davis, CSGS geologist, oral commun., 1986), but not logged or analyzed in this part of the study. Underlying this material and extending to a depth of 68.5 ft, the lithology is primarily a non- to very silty, noncalcareous claystone. Beginning about 36 ft, moisture content is 0.82 weight percent lower than that at 24 ft. However, from the 36-ft level downward, there is a slight increase in moisture content, and a continued slight decrease in bulk density for the 20-68.5-ft interval.

From 68.5 to 108.0 ft, the sediment consists predominantly of claystone that varies from slightly silty to silty. Within this interval, there is a continued slight increase in moisture content from 15.08 to 16.44 percent and in bulk density from 2.06 to about 2.12. The last 39.5 ft of claystone material show a moderate reaction to HCl. Also present within this interval is a limestone bed 0.8 ft thick at 84.0 ft, and four bentonite beds present between 93.4-95.8 ft that vary in thickness from 0.5 to 1 in. One fracture, having a dip of 55^{o}, was observed at 106.4 ft. Based on our limited moisture data, this fracture appears to be within a "zone" (from 88.0 to 134.5 ft) of higher moisture content (fig. 2).

From 108.0 to 239.0 ft, the claystone varies from shaley to silty and is primarily noncalcareous except for a limy zone between 209.9 and 210.1 ft. Silt lamina are common within this interval; and silt bedding are only present below 209.0 ft. Moisture content decreases slightly from about 15.46 to 13.78, whereas, bulk density varies only by 0.001. Limestone beds having thicknesses of 0.8 and 0.4 ft were found at 149.4 and 182.35 ft, respectively. A possible "gouge zone" is present near the 113.0 depth and lies just below the fracture at 106.4 ft and within the high moisture "zone" (fig. 2).

The last interval, 239.0-277.0 ft, has three zones starting at 239.0, 249.0, and 259.0 ft in which claystone appears to grade downward into a clayey siltstone. Limestone beds are present at 242.6 and 269.0 ft with thicknesses of 0.80 and 3.0 ft, respectively. Only one moisture content (15.16 weight percent) and one bulk density (2.16) were determined within this interval. The apparent higher moisture content within this interval, as compared to that found within the 108.0-239.0-ft interval above (fig. 2), probably corresponds to the increase in silt content and silt lamina.

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
20.0-21.3	Claystone, silty.....	Medium dark gray (N3).	None.			
21.3-25.0	Claystone, very silty, noncalcareous.....	Medium gray to medium dark gray (N3-N4).	--do----	24.0	15.85	2.13
25.0-36.6	Claystone, noncalcareous.....	--do--------	--do----	36.0	15.03	2.12
36.6-40.0	Claystone, very slightly silty to non-silty, noncalcareous...	--do--------	--do----	---	---	---
40.0-48.0	Claystone, very, slightly silty to non-silty, noncalcareous.....	--do--------	--do----	44.0	15.05	2.11
48.0-58.5	Claystone, slightly silty, noncalcareous...	--do---------	--do----	---	---	---
58.5-68.5	Claystone, very slightly silty, noncalcareous. At 62.7 ft bentonite bed 1 in. thick..	--do---------	--do----	61.9	15.08	2.06

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
68.5-78.5	Claystone, silty, noncalcareous, burrows and one Pelecypod valve.....	Medium grey (N4).	--do----	---	---	---
78.5-88.5	Claystone, silty, noncalcareous. Limestone 84.0-84.8 ft.....	Medium gray (claystone) (N4); light gray (limestone) (N4).	--do----	88.0	15.12	2.13
88.5-98.5	Claystone, silty, noncalcareous. Four bentonite beds: (1) 1 in. thick at 93.4 ft; (2) 1 in. thick at 94.4 ft; (3) 1/2 in. thick at 94.9 ft; (4) 1 in. thick at 95.8 ft.....	Medium grey (N4).	--do----	---	---	---
98.5-108.0	Claystone, slightly silty, noncalcareous to moderately calcareous, burrows and one coiled Ammonite present.....	--do---------	One fracture at 106.4 ft. Flat fracture surface with a 55°dip. Slicks not visible due to mud coating.	100.0	16.44	2.12

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
108.0-110.7	Claystone, silty, non-calcareous...	--do----	None	---	---	---
110.7-113.0	Claystone, slightly silty, noncalcareous.	--do--------	Lower part of core could be gouge(?).	---	---	---
113.0-120.0	Claystone, slightly silty, non-calcareous...	Medium light gray to medium gray (N5-N6).	None.	115.5	15.46	2.13
120.0-130 3	Claystone, shaley, non-calcareous...	Medium dark gray (N3).	--do----	---	---	---
130.3-140.0	Claystone, silty, shaley with interbedded silt lamina.....	--do---------	--do----	134.5	14.70	2.15
140.0-149.5	Claystone, silty,very, slightly calcareous to noncalcareous. Coiled Ammonite at 137.8 ft and vertical burrows present.....	Medium light gray to medium gray (N5-N4).	--do----	144.6	14.49	2.14

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
149.5-159.0	Limestone, 149.4-150.2 ft; claystone, shaley, silty 150.2-151.2 ft; claystone, silty 151.2-159.0 ft.....	Medium light gray (N5).	--do----	---	---	---
159.0-169.0	Claystone, silty, noncalcareous with discontinuous interbedded silt lamina and beds. Horizontal burrows present.....	Medium dark gray (N3).	--do------	---	---	---
169.0-179.0	Claystone, silty, noncalcareous. Silt content increases downward. Silt lamina increases downward. Pelecypod at 172.6 ft.....	Medium gray (N4).	--do------	170.5	14.33	2.14

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
179.0-189.0	Claystone, silty 179.0-182.35 ft; limestone 182.35-182.75 ft; claystone shaley 182.75-189.0 ft.....	Very light gray to white (limestone) (N7-N8); medium dark gray (claystone) (N3).	--do------	---	---	---
189.0-199.3	Claystone, silty, non-calcareous. Becomes shaley and moderately calcareous 198.4-199.3 ft.	Medium gray (N4).	--do------	195.5	14.37	2.15
199.3-209.0	Claystone, silty with discontinuous silt lamina 199.3-202.3 ft; claystone, shaley 202.3-203.3 ft; claystone, silty with discontinuous silt lamina 203.2-209.0 ft. Whole interval slightly to non-calcareous. Horizontal burrows present throughout.....	--do---------	--do----	---	---	---

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
209.0-219.0	Claystone, silty, non-calcareous. Silt lamina and bedding throughout. Horizontal burrows present. A limy zone 209.9-210.1 ft.	Medium gray to medium dark gray (N4-N3).	--do----	215.0	13.74	2.17
219.0-229.0	Claystone, very, slightly silty to non-silty, noncalcareous 219.0-228.8 ft; Claystone, silty, noncalcareous with silt beds and lamina 228.8-229.0 ft.....	Dark gray (N2).	--do----	---	---	---
229.0-239.0	Claystone, silty, interbedded siltstone, moderately calcareous. Horizontal and vertical burrows present.....	Medium dark gray (silty Claystone) (N3), Medium light gray (siltstone) (N6).	--do----	229.5	13.78	2.18

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
239.0-249.0	Claystone, silty changing to siltstone, clayey, non-calcareous with silt lamina. Limestone, vuggy 242.6-243.4 ft.	Medium gray (claystone and clayey siltstone) (N4).	--do----	---	---	---
249.0-259.0	Claystone, silty changing to siltstone, clayey, non-calcareous. Burrows and brown pelecypod shell fragment present.....	Medium light gray (clayey siltstone) (N5); medium dark gray (silty claystone) (N3).	--do----	251.5	15.16	2.16
259.0-269.0	Claystone, silty, non-calcareous. Increase in silt downward to become siltstone, clayey, noncalcareous. Calcareous 268.8-268.85 ft. Horizontal burrows present.....	Medium gray to dark gray (N4-N3).	--do----	---	---	---

TABLE 1. Selected moisture and bulk density determinations, natural fracture, and generalized lithologic descriptions of core from the Colorado State Geological Survey drill hole 10--Continued

[--- indicates information is unavailable]

Depth in tenths of ft	Description	Color	Natural fracture description	Depth[1] of sample (ft)	Moisture[2] content (pct. wt)	Bulk[2] density (gm/cc)
269-277.0	Claystone, silty; limestone 269.0-272.0 ft.....	Medium dark gray (claystone) light gray to white (limestone) (N7-N8).	--do----	---	---	---

[1] Approximate depth (ft) of sample used for moisture content and bulk density determinations.

[2] Value represents average of three tests.

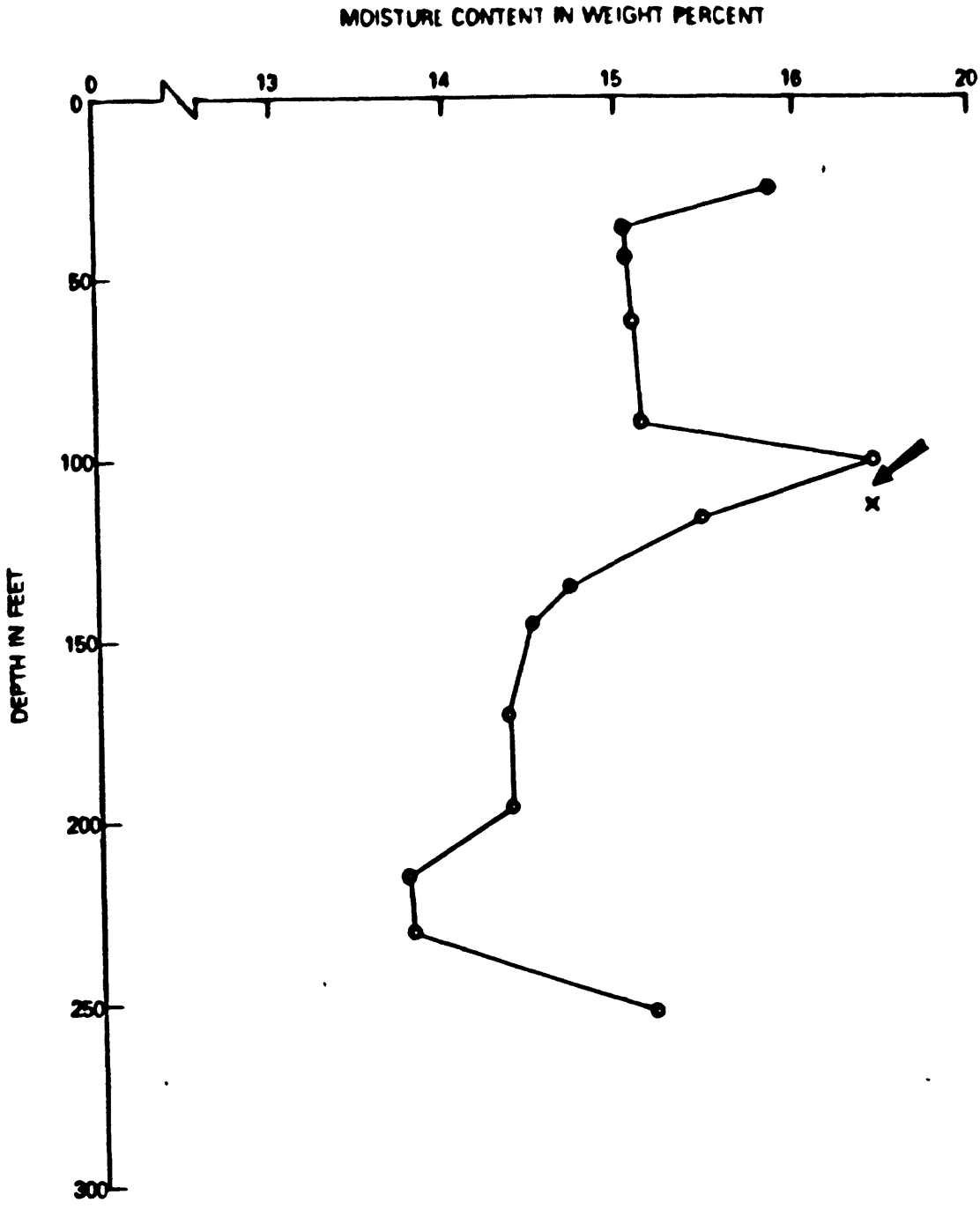

Figure 2. Graphic representation of depth versus moisture content. Open circle represents an average value of three moisture tests. Arrow indicates the location of the only confirmed fracture within logged core. X indicates position of possible gouge material.

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2. Rock-color Chart, 1975, The Geological Society of America, Boulder, Colorado, 10 p.

3. U.S. Geological Survey, 1976, Adams County, Colorado, topographic map: U.S. Geological Survey, scale 1:50,000, sheet 3.