RESEARCH INSTITUTE Earth Science Lab. DEPARTMENT OF THE INTERIOR PREPARED IN COOPERATION WITH THE MISCELLANEOUS INVESTIGATIONS SERIES UNITED STATES GEOLOGICAL SURVEY COLORADO STATE MINING INDUSTRIAL DEVELOPMENT BOARD 3 MI. TO COLORADO 9 CORRELATION OF MAP UNITS MANCOS SHALE (UPPER AND LOWER CRETACEOUS)—Gray to dark-gray marine shale. Sandstone beds near the top. Calcareous sandstone of Upper Cretaceous Frontier Sandstone Member 300-400 ft (90-122 m) above base, overlain by calcareous shale zone equivalent to Niobrara Formation. Silver-gray siliceous shale of Lower Cretaceous Mowry Shale Member at base. Thickness north of Colorado River about 5,000 ft (1,525 m); south of river, >6,000 ft (1,820 m) Upper unit of Mancos Shale (Upper Cretaceous)—Mancos Shale above the Frontier Sandstone Member Frontier Sandstone and Mowry Shale Members and intervening shale zone (Upper and Lower Cretaceous)—Thickness about 500 ft (152 m) COLORADO GROUP (UPPER AND LOWER CRETACEOUS)—Consists of Upper Cretaceous Niobrara Formation (calcareous shale and marly limestone) and Upper and Lower Cretaceous Benton Shale, which has calcareous sandstone equivalent to Frontier Sandstone Member of Mancos Shale at top and siliceous shale equivalent to Mowry Shale Member at base. Thickness 800-1,000 ft (244-305 m) DAKOTA SANDSTONE (LOWER CRETACEOUS)—Light-gray and tan sandstone or quartzite; some interbedded dark shale and shaly sandstone. Resistant, widely exposed unit but too thin to show separately at map scale in many areas. Thickness 125–225 ft (37–68 m) DAKOTA SANDSTONE AND BURRO CANYON FORMATION (LOWER CRETACEOUS)— Mapped only in Aspen-Basalt area Burro Canyon Formation—Yellow sandstone and green claystone. Maximum thickness 225 Kfd FRONTIER SANDSTONE AND MOWRY SHALE MEMBERS OF MANCOS SHALE AND DAKOTA SANDSTONE MORRISON FORMATION (UPPER JURASSIC)—Variegated shale and mudstone, light-gray sandstone, and local beds of gray and green-gray limestone. Locally conglomeratic near base. Thickness about 500 ft (152 m) along Grand Hogback and along Colorado River near Burns; thins eastward and southeastward to <200 ft (60 m) in Blue River valley CURTIS FORMATION (UPPER JURASSIC)—Yellowish-gray to pale-green glauconitic sandstone and oolitic limestone. Thickness < 100 ft (30 m) ENTRADA SANDSTONE (UPPER JURASSIC)—Light-gray to orange crossbedded sandstone. Lower Cretaceous Thickness 75–150 ft (23–46 m) in northwest and central parts of quadrangle; wedges out southward in Aspen area and eastward at Gore Range Upper Jurassic DAKOTA FORMATION AND MORRISON FORMATION Lower Jurassic DAKOTA, MORRISON, CURTIS, AND ENTRADA FORMATIONS ALONG COLORADO RIVER NEAR BURNS AND STATE BRIDGE; ELSEWHERE, DAKOTA, MORRISON. Upper Triassic AND ENTRADA FORMATIONS Lower Triassic MORRISON, CURTIS, AND ENTRADA FORMATIONS MORRISON AND ENTRADA FORMATIONS GLEN CANYON SANDSTONE (LOWER JURASSIC AND UPPER TRIASSIC)—Light-brown to light-gray crossbedded sandstone that closely resembles the overlying Entrada Sand-PENNSYLVANIAN stone, from which it is separated by a subtle unconformity. Maximum thickness 75 ft (23 m) MORRISON, ENTRADA, AND GLEN CANYON FORMATIONS HINLE FORMATION (UPPER TRIASSIC)—Brownish- and purplish-red calcareous siltstone, mudstone, and sandstone; limestone-pellet conglomerate in lower part; Gartra Sandstone Member at base (pale-purple to white pebbly sandstone 25 ft or 8 m thick). Thickness ORDOVICIAN 1,200 ft (365 m) near Brush Creek south of Eagle; thins from there in all directions; wedges out beneath pre-Entrada unconformity along west side of Gore Range and in Elk Mountains southwest of Aspen MORRISON, ENTRADA, AND CHINLE FORMATIONS-Along Grand Hogback south of T. 6 S., Chinle is represented only by the Gartra Member STATE BRIDGE FORMATION (LOWER TRIASSIC AND PERMIAN)—Orange-red to redbrown siltstone and sandstone. Thickness at least 5,000 ft (1,525 m) in local depositional basin in Hardscrabble Mountain area south of Eagle. To the north, unit is 500 ft (152 m) thick and thins eastward to wedge out along west flank of Gore Range. To the southwest, unit is 2,400 ft (732 m) thick along Fryingpan River east of Basalt but absent beneath pre-Chinle and pre-Entrada unconformities at Grand Hogback and in Elk Mountains CHINLE AND STATE BRIDGE FORMATIONS MAROON FORMATION (PERMIAN AND PENNSYLVANIAN)—Maroon and grayish-red sandstone, conglomerate, and mudstone; lower part intertongues with Eagle Valley Formation or DESCRIPTION OF MAP UNITS Evaporite which underlies the Maroon in places. Thickness >9,500 ft (2,900 m) in area southwest of Aspen; thins northeastward to depositional margin along west flank of Gore Formations for which no map symbol is shown are grouped with other stratigraphic units to form map units Range; thinning also due to pre-State Bridge unconformity UNCONSOLIDATED DEPOSITS (HOLOCENE): WEBER SANDSTONE (PERMIAN AND PENNSYLVANIAN)—Yellow-gray sandstone. Alluvium—Gravel, sand, and sitt in stream valleys and alluvial fans Thickness about 100 ft (30 m) near northwest corner of quadrangle; thins toward depositional margin to south and east; present margin south of Glenwood Springs, east of Eagle, Eolian deposits—Windblown sand and silt and east of Burns results in part from truncation beneath pre-State Bridge unconformity PPwm WEBER SANDSTONE AND MAROON FORMATION Talus deposits and rock glaciers CHINLE, STATE BRIDGE, AND MAROON FORMATIONS LANDSLIDE DEPOSITS (HOLOCENE AND PLEISTOCENE)—On Grand and Battlement Mesas (southwestern corner of quadrangle), consist principally of large slump blocks of MINTURN FORMATION (PENNSYLVANIAN)—Gray, pale-yellow, and red sandstone, grit, basalt irregularly veneered with young (Pinedale) glacial drift. Elsewhere, include mudconglomerate, and shale, and scattered beds and reefs of carbonate rocks. Includes rocks flow and some talus deposits. Many small bodies not mapped of Gothic Formation of Langenheim (1952). Thickness near Minturn >6,000 ft (1,830 YOUNG BASALT (HOLOCENE AND PLEISTOCENE)—In Roaring Fork valley north of Aspen, m); thins abruptly eastward toward depositional margin along west flank of Gore Range and 1.5 m.y. (million years) old; along Rock Creek north of McCoy, 0.64 m.y. old (Larson and at Breckenridge. Thins westward and intertongues with Eagle Valley Evaporite in Eagle others, 1975, p. 166). Near Dotsero, 4,150 years old (Giegengack, 1962) basin. Thickness on western side of basin, in Elk Mountains, about 3,000 ft (915 m). Volcanic cinder cone or crater East and north of Sawatch Range, contact with overlying Maroon Formation is placed at top of highest marine limestone; west of Sawatch Range and White River Plateau, contact is UNCONSOLIDATED DEPOSITS (PLEISTOCENE): at color change from predominantly gray (Minturn) below to predominantly red (Maroon) Young gravels (Bull Lake and younger)—Stream, terrace, and outwash gravels Young glacial drift (Bull Lake and younger)—Unsorted bouldery glacial deposits (till) and BELDEN FORMATION (PENNSYLVANIAN)—Dark-gray to black shale, carbonate rocks, and associated sand and gravel deposits sandstone. Map unit includes local thin lenses of Molas Formation (Pennsylvanian) Old gravels and alluviums (pre-Bull Lake)—Terrace, outwash, and pediment gravels at base. Maximum thickness in Elk Mountains and White River Plateau area about 900 ft (275 m); thins eastward to depositional margin along Gore Range and near Hoosier Pass Old glacial drift (pre-Bull Lake)—Unsorted bouldery glacial deposits (till); morainal form sub-Pmb MINTURN AND BELDEN FORMATIONS HIGH-LEVEL ALLUVIUM (PLEISTOCENE AND/OR PLIOCENE)—Fine-grained to bouldery Evaporite-bearing facies of Minturn and Belden Formations—Mapped only in South Park, alluvial deposits and gravels preserved mainly on ridge tops; may not all be of same in southeast corner of quadrangle age; in southwest part of quadrangle, characterized by abundant basalt boulders and in Pe EAGLE VALLEY FORMATION (PENNSYLVANIAN)—Gray and reddish-gray siltstone, shale, places has been mapped previously as basalt sandstone, carbonate rocks, and local lenses of gypsum. Unit is transitional between the BROWNS PARK FORMATION (MIOCENE)—Fluvial ashy siltstone, claystone, sandstone, coarse clastic rocks of the Minturn and Maroon Formations and purely evaporitic rocks. conglomerate, and thin beds of air-fall ash; loosely consolidated; conglomerate at base. Thickness variable, depending on intertonguing relations Locally interbedded with basalt (Tbb unit). Thickness >1,000 ft (305 m) south of State Pee EAGLE VALLEY EVAPORITE (PENNSYLVANIAN)—Gypsum, anhydrite, and interbedded siltstone and minor dolomite; contains thick salt at depth in some places, as shown by TROUBLESOME FORMATION (MIOCENE)—Chiefly siltstone; contains many beds of volcanic wells drilled for oil and gas. Intertongues with Minturn, Belden, and Maroon Formations ash and some of sandstone and conglomerate. Thickness >500 ft (152 m) in Williams and grades into fine-grained clastic rocks of Eagle Valley Formation. Diapiric in structural Fork valley. Term is used in Middle Park for Miocene rocks largely equivalent to Browns configuration in many places, especially in large area in central part of quadrangle. Thick-Park Formation west of the Gore Range DRY UNION FORMATION (PLIOCENE AND MIOCENE)—Light-brown sandy siltstone and in-MISSISSIPPIAN AND DEVONIAN ROCKS—Includes rocks of, Leadville Limestone (or Doloterbedded friable sandstone, conglomerate, and volcanic ash. Thickness >3,000 ft (915 mite) (Mississippian) and Chaffee Group (Mississippian? and Devonian). Leadville thickm) in Arkansas River valley southwest of Leadville ness variable beneath pre-Belden unconformity; maximum of about 275 ft (84 m) in Elk BASALT OF BIMODAL SUITE (PLIOCENE AND MIOCENE)—Dense black resistant alkali Mountains; truncated eastward along west flank of Gore Kange and near Hoosier Pass basalt in lava-flow layers 5–200 ft (1.6–61 m) thick, and interbedded tuffs and volcanic con-Chaffee Group consists of Gilman Sandstone (Mississippian or Devonian), Dyer Dolomite Pmbe glomerates. Greatest preserved thicknesses are 900 ft (275 m) on White River Plateau (Mississippian? and Devonian) and Parting Formation (Devonian). Maximum thickness of and 800 ft (244 m) on Grand Mesa. Ages determined from several localities range Chaffee Group 250 ft (76 m) in White River Plateau area; truncated beneath prefrom 8 to 23 m.y. (Larson and others, 1975) Belden unconformity along west flank of Gore Range and near Hoosier Pass O€r ORDOVICIAN AND CAMBRIAN ROCKS—Includes various combinations of: Fremont Lime-BASALTIC DIKES AND PLUGS (PLIOCENE AND MIOCENE)—Probable feeders of basalt flows of Tbb unit; also intrusive into the flows stone (Ordovician), Harding Sandstone (Ordovician), Manitou Dolomite (Ordovician), Dotsero Formation (Cambrian), Peerless Formation (Cambrian), and Sawatch Quartzite Interior—Geological Survey, Reston, Va.—1978—G76225 (Cambrian). Fremont is present beneath pre-Parting unconformity only in western Elk BUENA VISTA 14 MI. Thr RHYOLITIC ROCKS OF BIMODAL SUITE (PLIOCENE AND MIOCENE)—In plugs, dikes, Base from U.S. Geological Survey, 1956-62 SCALE 1:250 000 Mountains. Harding is present beneath pre-Parting and pre-Fremont unconformities only Geology compiled in 1973-75 100,000-foot grid based on Colorado coordinate in western Elk Mountains and along Eagle River from Minturn area to Tennessee Pass. system, central and north zone Manitou is widespread but in eastern part of quadrangle is absent beneath pre-Harding and 10,000-meter Universal Transverse Mercator grid Tui UPPER TERTIARY INTRUSIVE ROCKS (MIOCENE)—Sodic granite of Treasure Mountain younger unconformities from Pando and Breckenridge northward. Dotsero is mapped ticks, zone 13, shown in blue only in White River Plateau area. Peerless and Sawatch are widespread but are truncated south of Marble, and satellitic plugs and dikes. About 12.5 m.y. in age (Obradovich and CONTOUR INTERVAL 200 FEET beneath various unconformities along Gore Range and near Breckenridge. Maximum WITH SUPPLEMENTARY CONTOURS AT 100 FOOT INTERVALS thickness of Ordovician and Cambrian rocks about 750 ft (230 m) in White River Plateau DATUM IS MEAN SEA LEVEL ASH-FLOW TUFF (OLIGOCENE)—Dense silicic welded tuff and vitrophyre; principally in 1978 MAGNETIC DECLINATION FOR THIS SHEET VARIES FROM 14°00' EASTERLY FOR THE CENTER OF THE WEST FDGE M€r MISSISSIPPIAN, DEVONIAN, ORDOVICIAN, AND CAMBRIAN ROCKS Grizzly caldera south of Independence Pass in Sawatch Range INTER-ASH FLOW ANDESITIC LAVAS AND BRECCIAS (OLIGOCENE)—Mapped only at GRANITIC ROCKS (PRECAMBRIAN Y— 1,400 m.y. AGE GROUP)—Includes Silver Plume and St. Kevin Granites and equivalents Buffalo Peaks in southeast corner of quadrangle 6. Tweto, Ogden, and Lovering, T. S., 1977, Geology of the Minturn 1518. Kucera R. E., 1962, Geology of the Yampa district, northwest Colorado: GRANITIC ROCKS (PRECAMBRIAN X— 1,700 m.y. AGE GROUP)—Includes Cross Creek 31. Moench, R. H., Hanshaw, P. M., Freeman, V. L., Powell, J. C., and PRE-ASH FLOW ANDESITIC LAVAS AND BRECCIAS (OLIGOCENE)—Mapped only in 45. Donnell, J. R., and Yeend, W. E., 1968, Geologic map of the North Granite of Gore and northern Sawatch Ranges, Denny Creek Granodiorite of central minute quadrangle, Eagle and Summit Counties, Colorado; U.S. Colorado Univ. Ph. D. thesis, 675 p. Agard, S., U.S. Geol. Survey reconnaissance mapping. Mamm Peak quadrangle, Garfield County, Colorado: U.S. Geol. The Flat Tops Grizzly caldera area south of Independence Pass in Sawatch Range Geol. Survey Prof. Paper 956, 96 p. MIDDLE TERTIARY INTRUSIVE ROCKS (OLIGOCENE; 26-38 m.y.)—Granodiorite and Sawatch Range, and equivalent rocks Poole, F. G., 1954, Geology of the southern Grand Hogback area, Survey open-file map. 19. Sharps, S. L., 1956, Geology of King Mountain, Routt County, Colorado EUCOCRATIC GRANITIC ROCKS (PRECAMBRIAN X)—Includes trondhjemitic Kroenke Garfield and Pitkin Counties, Colorado: Colorado Univ. M.S. quartz monzonite; generally porphyritic but equigranular in some large bodies; in stocks, ____1968, Geologic map of the Hawxhurst Creek quad-7. Tweto, Ogden, 1974, Geologic map and sections of the Holy Cross and correlation of pre-Mancos, post-Weber formations, northwestern Granodiorite in Sawatch Range, and granite at Taylor Pass southeast of Ashcroft Mountain dikes, sills, and irregular bodies thesis, 128 p. rangle, Garfield and Mesa Counties, Colorado: U.S. Geol. Survey Colorado: Colorado Univ. M.S. thesis, 92 p. in the Elk Mountains [15-minute] quadrangle, Eagle, Lake, Pitkin, and Summit Counties, Welder, G. E., 1954, Geology of the Basalt area, Eagle and Pitkin White River Plateau open-file map. GRANITIC ROCKS UNDIVIDED (PRECAMBRIAN Y AND X) Counties, Colorado: Colorado Univ. M.S. thesis, 72 p. Colorado: U.S. Geol. Survey Misc. Inv. Ser. Map I-830 [1975]. VOLCANIC ROCKS OF GREEN MOUNTAIN AREA (OLIGOCENE)—Trachytic lavas related 20. Stevens, C. 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Maximum preserved pre-Fennsylvanian carbonate rocks, McCoy area, Colorado: U.S. Counties, Colorado: U.S. Geol. Survey open-file map. (Contains layered hornblende gneiss and calc-silicate rocks. Parent materials mainly graywacke Geol Survey open-file report, 11 p... 48. Donnell, J. R., U.S. Geol. Survey unpub. maps. thickness on Battlement Mesa about 1,000 ft (305 m) list of other sources.) 33. Mutschler, F. E., 1970, Geologic map of the Snowmass Mountain quadand shale Beckett R. L., 1955, Structural geology of the Red Canyon area, Eagle Yeend, W. E., 1969, Quaternary geology of the Grand and Battlement GREEN RIVER FORMATION (EOCENE)—Marlstone, oil shale, siltstone, and sandstone. Unrangle, Pitkin and Gunnison Counties, Colorado: U.S. Geol. Survey Xf FELSIC GNEISSES (PRECAMBRIAN X)—Parent materials probably igneous rocks of inter-Mesas area, Colorado: U.S. Geol. Survey Prof. Paper 617, 50 p. Courty, Colorado: Colorado Univ. M.S. thesis, 36 p. Battlement Mesa 26 27 9. 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Plateau northwest of Rifle; thins southward to wedge edge near south boundary of quadminor marble and probably is metasedimentary Survey Geol. Quad. Map GQ-512. INDEX SHOWING SOURCES OF GEOLOGIC DATA 22. Stauffer, J. E., 1953, Geology of an area west of Wolcott, Eagle County, Xfh INTERLAYERED FELSIC AND HORNBLENDIC GNEISSES (PRECAMBRIAN X) 10. Tweto, Ogden, U.S. Geol. Survey reconnaissance mapping. Lower part of Green River Formation—Shale, sandstone, and marlstone in the Anvil Points, 35. Godwin, L. H., 1968, Geologic map of the Chair Mountain quadrangle, Colorado: Colorado Univ. M.S. thesis, 56 p. Garden Gulch, and Douglas Creek Members. Thickness >2,000 ft (610 Gunnison and Pitkin Counties, Colorado: U.S. Geol. Survey Geol. Grand Mesa 11. Donner, H. F., 1949, Geology of the McCoy area, Eagle and Routt m) on Roan Plateau northwest of Rifle; thins southward to wedge edge near south boundary 23. Tweto, Ogden, and Reed, J. C., Jr., U.S. Geol. Survey reconnaissance Quad. Map GQ-704. ----- CONTACT Counties, Colorado: Geol. Soc. America Bull., v. 60, no. 8, p. 1215of quadrangle LOCALITY MAP OF MAJOR GEOGRAPHIC FEATURES 36. Trask, N. J., Jr., 1956, Geology of the Buford area, Rio Blanco County, WASATCH AND OHIO CREEK FORMATIONS: GEOLOGIC SOURCES FAULT—Dotted where concealed. Bar and ball on downthrown side Schmidt, P. B., 1961, The geology of the State Bridge area, Colorado: 24. Freeman, V. L., 1972, Geologic map of the Woody Creek quadrangle Colorado: Colorado Univ. M.A. thesis, 90 p. Wasatch Formation (Eocene and Paleocene)—Variegated claystone, siltstone, sandstone, Colorado Univ. M.S. thesis, 67 p. Pitkir and Eagle Counties, Colorado: U.S. Geol. Survey Geol. Quad. THRUST FAULT—Dotted where concealed. Sawteeth on upper plate and conglomerate; carbonaceous shale and lignite near base. Maximum thickness about 1. Tweto, Ogden, and Reed, J. C., Jr., 1973, Reconnaissance geologic 37. Tweto, Ogden, and Moench, R. H., U.S. Geol. 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SYNCLINE—Showing troughline; dotted where concealed LARAMIDE INTRUSIVE ROCKS (EOCENE, PALEOCENE, AND UPPER CRETACEOUS; SANTA FE 14. Reed, J. C., Jr., U.S. Geol. Survey reconnaissance mapping. 40. O'Sullivan, R. B., U.S. Geol. Survey unpub. map. 3. _____1974, Geologic map of the Mount Lincoln 15-minute 40-72(?) m.y.)—Quartz monzonite, granodiorite, and quartz diorite porphyries in stocks, MONOCLINE—Showing anticlinal crestline of steep dip; dotted where concealed Clark, J. H., 1960, Geology of the East Lake Creek area, Eagle County, 1971, Geologic map of the Aspen quadrangle, Pitkin quadrangle, Eagle, Lake, Park, and Summit Counties, Colorado: W/) MEXICO Colorado: Colorado Univ. M.S. thesis, 71 p. U.S. Geol. Survey Misc. Field Studies Map MF-556. (Contains list County, Colorado: U.S. Geol. Survey Geol. Quad. Map GQ-933. 41. Fisher, R. P., 1960, Vanadium-uranium deposits of the Rifle Creek area, Hubert, J. 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AND OTHER PUBLISHED 1°×2° QUADRANGLE MAPS affected by major flowage or diapirism of evaporitic rocks 2,400 ft (732 m); near Carbondale, where Rollins Sandstone Member is at base, 1,400 ft igneous rocks in northwestern Colorado: Geol. Soc. America Abstracts with Programs, v. 5, no. 6, p. GEOLOGIC MAP OF THE LEADVILLE 1°×2° QUADRANGLE, NORTHWESTERN COLORADO

Compiled by

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PIERRE SHALE (UPPER CRETACEOUS)—Dark-gray marine shale containing a few thick beds of fine-grained sandstone. Maximum preserved thickness 5,000-6,000 ft (1,525-1,830 UNIVERSITY OF UTAH