DEPARTMENT OF THE INTERIOR
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# MAP SHOWING OUTCROPS OF THICK, DOMINANTLY ARGILLACEOUS SEDIMENTARY AND METASEDIMENTARY ROCKS, BASIN AND RANGE PROVINCE, SOUTHERN CALIFORNIA

Compiled by William D. Johnson, Jr.

## INTRODUCTION

This map report is one of a series of geologic and hydrologic maps covering all or parts of States within the Basin and Range province of the western United States. The map reports contain detailed information on subjects that characterize the geohydrology of the province, including the ground-water hydrology, ground-water quality, surface distribution of selected rock types, tectonic conditions, geophysics, Pleistocene lakes and marshes, and mineral and energy resources. This work is a part of the U.S. Geological Survey's program for geologic and hydrologic evaluation of the province to identify potentially suitable regions for further study relative to isolation of high-level nuclear waste (Bedinger, Sargent, and Reed, 1984).

This map was prepared from published geologic maps and reports, utilizing the project guidelines defined in Sargent and Bedinger (1984). For this study, argillaceous sedimentary and metasedimentary rocks include shale, claystone, mudstone, siltstone, argillite, slate, and schist. The argillaceous units commonly include non-argillaceous rocks, such as sandstone and limestone, which were deposited with the argillaceous rocks. The project guidelines call for mapping argillaceous rocks more than 500 ft thick, but because argillaceous rocks may impede the movement of ground-water and commonly have sorptive properties, locally units of lesser thickness were included. In the Description of Map Units the age, lithologic character, thickness, and sources of data are described for the argillaceous units within arbitrarily outlined and numbered areas in counties in the study area.

DESCRIPTION OF MAP UNITS
[To convert feet (ft) to meters, multiply feet by 0.3048]

| County-area number | Map symbol | Geologic unit | Geologic age | Lithology and comments | References for county area |
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| | | | INYO COUNTY (I) | | |
| I-1 | Ꞓcm | Campito Formation, Montenegro Member | Early Cambrian | Silty to sandy fissile shale and slate, and fine-grained sandstone; contains quartzitic siltstone and and quartzitic sandstone southward in the White Mountains. Locally metamorphosed to hornfels. Montenegro is the upper member of the Campito Formation. About 600 ft thick in northern outcrops. | Bateman, 1965; Crowder and Sheridan, 197 Krauskopf, 19 Nelson, 1962, 1966a, 1966b |
| | Ꞓh | Harkless Formation | Early Cambrian | Silty shale containing generally thin quartzite beds, but locally beds are thick and massive. In places some thin limestone in basal part. About 1,000 to 2,000 ft thick. | |
| I-2 | Ꞓh | Harkless Formation | Early Cambrian | Upper sequence (600 to 700 ft), siltstone and shale. Middle sequence (2,000 ft), quartzite, siliceous siltstone, and minor thin limestone. Lower sequence (300 ft), sandstone and siltstone. Harkless averages about 2,500 ft thick. | McKee, 1968; McKee and Nelson, 1967; Nelson, 1966a Ross, 1967a |
| | ꞒZc | Campito Formation, undivided | Early Cambrian and Late Proterozoic | Upper part of shale and interbedded quartzitic siltstone and sandstone. Lower, generally thicker, part of massive quartzitic sandstone and quartzite and interbeds of siltstone and shale. Formation is 3,000 ft thick. | |
| I-3 | Mrs | Rest Spring Shale | Late Mississippian | Not described. | Ross, 1967a |
| I-4 | Mrs | Rest Spring Shale | Late Mississippian | Siltstone, shale, and mudstone, and minor limestone. | Nelson, 1966a 1966b, 1971; Ross, 1965, 1966, 1967b |
| | Ꞓh | Harkless Formation | Early Cambrian | Upper part, siltstone and shale, and minor limestone. Middle part, lenticular thick- to medium-bedded quartzite containing shale interbeds. Unit constitutes majority of formation in southern part of area. Basal part, distinct unit a few hundred ft thick of dark quartzite and siltstone. Locally, at south end of area formation metamorphosed to phyllite, schist, and quartzite. Harkness ranges from 1,000 to about 1,500 ft thick. | |

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| | ЄZc, Єcm | Campito Formation, undivided; locally, the upper member, the Montenegro (Єcm), is differentiated | Early Cambrian and Late Proterozoic | Upper part, shale and interbedded quartzitic siltstone and quartzitic sandstone. Locally, mappable as the Montenegro Member (Lower Cambrian). Lower part, massively bedded quartzitic sandstone and interbedded siltstone and shale (Andrews Mountain Member). | |
| I-5 | Mrs | Rest Spring Shale | Late Mississippian | Dark shale, mudstone, and siltstone. Formation is 2,500 ft thick. | Nelson, 1962, 1965, 1966b; Ross, 1965, 1966 |
| | Ssc | Sunday Canyon Formation | Middle Silurian | Intermixed calcareous siltstone and shale, and argillaceous limestone. Maximum thickness of 683 ft. | |
| | Єml | Monola Formation | Middle Cambrian | Limey siltstone, shaly siltstone and thin-bedded silty limestone. Formation is 660 ft thick. | |
| | Єh | Harkless Formation | Early Cambrian | Silty shale and generally thin beds of quartzite, but locally beds are thick and massive. Locally, metamorphosed to schist and metaquartzite. | |
| | Єcm | Campito Formation, Montenegro Member | Early Cambrian | Shale, and interbedded quartzitic siltstone and quartzitic sandstone. | |
| I-6 | Mrs | Rest Spring Shale | Late Mississippian | Siltstone in upper part grading downward into shale. Locally, several thick limestone beds in upper 100 ft. Few beds of sandstone. Locally, metamorphosed to hornfels. Thickness ranges from 200 to maximum of 1,500 ft just west of Ubehebe Peak. | Burchfiel, 1969; McAllister, 1952, 1956; Nelson, 1965; Ross, 1966, 1967b |
| | Єml | Monola Formation, lower member | Middle Cambrian | Siltstone and shale, in places containing minor limestone, especially near top of member. Along longitude 117° 45' the lower member of the Monola apparently extends laterally eastward into lower part of Carrara Formation. Nelson (1965), however, states that the entire Monola is equivalent to the upper part of the Carrara. Lower member of Monola is 660 to 800 ft thick. | |
| | Єc | Carrara Formation | Middle and Early Cambrian | Upper unit (900 to 1,200 ft), dominantly limestone and some siltstone. Lower unit (600 ft), shale, silty limestone, sandstone, and quartzite. Carrara is 1,500 to 1,800(?) ft thick. | |

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| I-7 | Mrs | Rest Spring Shale | Late Mississippian | Mostly dark clay shale and argillite containing interbeds of sandstone and silty shale and locally thin to thick limestone lenses. In Cerro Gordo Peak area this unit was designated by Merriam (1963) as Chainman Shale, the upper part of which he thought correlates with the Rest Spring Shale. Shale is about 300 ft thick in Cerro Gordo Peak area. | McAllister, 1952, 1956; Merriam, 1963; Ross, 1966, 1967a |
| I-8 | Po | Owens Valley Formation, basal siltstone unit | Early Permian | Formation predominantly limestone but includes 400 to 450-ft thick basal siltstone near Darwin and in Argus Range. Siltstone is siliceous and contains interbeds of very thin bedded limestone. Known outcrops restricted to two localities. | Hall, 1971; Hall and MacKevett, 1962 |
| I-9 | $Z_j$ | Johnnie Formation | Late Proterozoic | In northern part of Panamint Range Johnnie Formation is mostly shale, but in southern part upper one-third is shale or argillite interbedded with quartzite and capped in places by thick dolomite; middle one-third is shale capped by dolomite, and the lower one-third interbedded dolomite, and sandstone or quartzite. In southern part of the Panamint Range the upper argillaceous unit of Johnnie Formation is probably 1,200 to 1,700 ft thick and was mapped separately by Johnson (1957). Formation is 2,000 to about 4,000 ft thick. | Hunt and Mabey, 1966; Johnson, 1957; McDowell, 1974 |
| I-10 | Mrs | Rest Spring Shale | Late Mississippian | Shale and silstone interbedded with generally thin limestones which are more abundant in upper part; 750 ft thick. | Hunt and Mabey, 1966 |
| I-11 | ꞒpꞒu | Unnamed unit | Early Cambrian to Late Precambrian | Composite unit of several formations, including the Johnnie Formation (Late Proterozoic), of shale, quartzite, siltstone, and dolomite. Thickness unknown. | Streitz and Stinson, 1974 |
| | | | SAN BERNARDINO COUNTY (S) | | |
| S-1 | Ꞓp | Pioche Shale | Middle and Early Cambrian | Thick shale interspersed with generally thinner limestones and dolomites which are more abundant in upper part. Formation is 1,004 ft thick. | Hewett, 1956 |
| S-2 | Ꞓp | Pioche Shale | Middle and Early Cambrian | Mostly slate, siltstone, and sandstone and subordinate phyllite, quartzite, and limestone. Locally, limestone bed is as much as 240 ft thick. Crops out mainly in thrust sheets. | Evans, 1971 |

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