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WATER-BEARING PROPERTIES OF SELECTED GEOLOGIC MATERIALS IN MINING AREAS OF GRANT COUNTY, NEW MEXICO

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ABSTRACT — Investigations related to mining activities in Grant County have resulted in the development of significant amounts of information on ground-water occurrence and water-bearing properties of geologic materials in the principal mining areas of the county. This information is seldom published, but constitutes a valuable resource for present and future efforts to understand and manage ground-water resources in the area. This paper presents summary data from well tests performed in the principal central Grant County mining areas, including the Tyrone area, approximately 15 km southwest of Silver City, the Fierro-Hanover area approximately 10 km northeast of Bayard, the Santa Rita area about 6 km east of Bayard, and the Hurley area. A brief survey of published resources on ground-water occurrence in Grant County is also included.

INTRODUCTION

Grant County has historically been, and remains a relatively sparsely populated area. Much of the early ground-water information in published literature on Grant County focuses on ground-water supply near active or prospective mining areas of the county. Later published work is related more to identification of water resources for public water supply in the populated areas, primarily in the central portion of the county, as well as identification of ground-water resources in agricultural areas along the Gila and Mimbres Rivers and in the Mimbres and Lordsburg ground-water basins in the southern portion of the county.

Many unpublished ground-water studies have been performed in Grant County for public and private entities. Some of this information is proprietary; however much is public and on file at New Mexico state government agencies, including the New Mexico Office of the State Engineer and the New Mexico Environment Department. The New Mexico Office of the State Engineer maintains records of approximately 4700 permitted water wells in Grant County. Unpublished water data may also be available at local government offices such as the Grant County Land Use and Planning Department and various municipalities and public water supply entities.

PUBLISHED INVESTIGATIONS

Darton (1916) prepared a description of the underground water resources of the Silver City quadrangle that was included in area mapping and investigation presented by Paige (1916). Paige (1922) also included descriptive ground-water information in an investigation of the Tyrone mining district. Tanner (1925) developed information on the ground-water resources in Silver City; this investigation was followed by another investigation of present and potential water supplies for the town by Wells and Meinzer (1926). Lasky (1936 and 1938) presented ground-water information with descriptions of ore deposits in the Bayard area and the Little Hatchet Mountains. Theis (1942) performed an evaluation of ground-water supplies in the vicinity of Ft. Bayard. Conover and Akin (1942) reported on ground-water supplies of the Mimbres Valley. Winkler (unpubl, 1953) reported on a ground-water survey at Silver City. Bushman (1955) presented ground-water data obtained from the Dwyer quadrangle

approximately 19 km southeast of Hurley. Koopman et al. (1969) presented an appraisal of water resources of the Silver City area. Trauger's (1972) report on the water resources and general geology of Grant County includes extensive raw data and detailed analyses of ground-water conditions in Grant County. Trauger's report includes lists and data obtained from nearly 1700 water wells and 60 springs in the county; chemical data from analysis of approximately 200 surface-water and ground-water samples were also included. The New Mexico Interstate Stream Commission (1975) presented water-resources assessment for planning purposes for New Mexico counties, including Grant County.

UNPUBLISHED DATA

This paper contains summary data on the water-bearing properties of geologic materials obtained from selected well tests in several mining areas of central Grant County. General locations of testing areas are shown in Figure 1. This diagram shows the locations of the Tyrone, the Fierro-Hanover, the Santa Rita and Hurley areas where tests were performed. Summary hydraulic conductivity and storativity values obtained from tests in each area are presented in Table 1. Results of 256 tests performed on wells completed in 19 recognized geologic units are represented. Test results are presented by area.

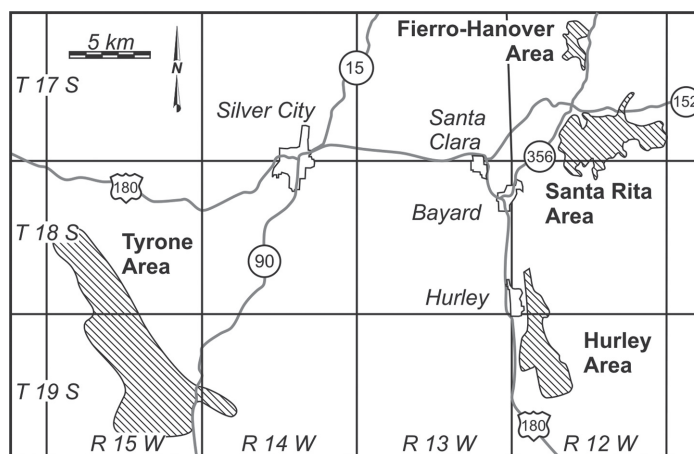


FIGURE 1. Map showing principal mining areas of central Grant County and general locations of well tests summarized in Table 1.

TABLE 1. Summary of aquifer test results from principal mining areas of central Grant County, New Mexico

Area	Geologic Unit	Hydraulic Conductivity Range (ft/d)	Hydraulic Conductivity Geometric Mean (ft/d)	Storativity Range	Storativity Geometric Mean	Number of Tests
Fierro-Hanover	Qal	4.5 to 20.7	9.69	--	--	2
Fierro-Hanover	Thg	4.5e-3 to 2.3	0.051	--	--	13
Fierro-Hanover	MI	2.7e-2 to 0.6	0.0714	--	--	3
Fierro-Hanover	Dp	4.5e-4 to 13.0	0.193	--	--	5
Fierro-Hanover	SOfm	1.0e-3 to 1.4	0.01	--	--	5
Hurley	Qtg	3.0e-2 to 800	13.9	0.10 to 0.15	.012	46
Santa Rita	Tba	6.4e-1 to 8.9	1.88	--	--	6
Santa Rita	Tk	2e-4 to 13.0	7.35e-3	--	--	25
Santa Rita	Trf	6.2e-7 to 75.0	1.77e-2	--	--	10
Santa Rita	Tg	9.0e-2 to 0.270	0.156	1e-4	1.0e-4	2
Santa Rita	Klp	6.5e-3 to 1.70	0.171	2.4e-5 to 0.27	1.64e-3	17
Santa Rita	Kep	5.7e-5 to 1.50	6.99e-2	1e-6 to 0.01	3.87e-5	21
Santa Rita	Kcu	6.2e-6 to 51	.021	2.4e-5 to 0.20	4.2e-3	15
Santa Rita	Kcs	4.9e-7 to 48	1.38e-3	--	--	8
Santa Rita	Kb	9.0e-5 to .011	4.63e-4	--	--	3
Santa Rita	Ps	2.3e-7 to 4.4e-4	3.5e-6	--	--	3
Santa Rita	Po	1.6e-3 to 4.6e-3	3.1e-3	--	--	4
Tyrone	Qtg	1.0 to 339.1	9.44	.014 to 0.073	.028	13
Tyrone	Tki	0.02 to 20.6	1.87	7.1e-6 to .035	1.95e-3	7
Tyrone	PCg	0.43 to 0.91	0.63	.08	.08	2

Notes

Qal	Quaternary alluvium
Qtg	Tertiary-Quaternary Gila Conglomerate
Tba	Tertiary basaltic andesite flows
Tki	Tertiary quartz monzonite-latitude intrusive (Tyrone)
Tk	Tertiary Neeling Nun rhyolite tuff
Trf	Tertiary Rubio Peak rhyolite-quartz latite flows
Tg	Tertiary granodiorite porphyry dikes associated with the Santa Rita stock
Thg	Tertiary granodiorite porphyry of the Hanover-Fierro Pluton
Klp	Cretaceous Hornblende quartz diorite (sills, laccoliths)
Kep	Cretaceous quartz diorite porphyry (sills and laccoliths)
Kcu	Cretaceous Colorado Formation, undivided (sandstone and shale members)
Kcs	Cretaceous Colorado Formation, lower shale member
Kb	Cretaceous Beartooth Quartzite
Ps	Pennsylvanian Syrena Formation (argillaceous limestone and shale)
Po	Pennsylvanian Oswaldo Formation (limestone, siliceous shale beds)
MI	Mississippian Lake Valley Limestone
Dp	Devonian Percha Shale
SOfm	Ordovician-Silurian Fusselman and Montoya Dolomites
PCg	Precambrian Burro Mountain Granite

Tyrone Area

The Tyrone area is approximately 15 km southwest of Silver City (Fig. 1). Tested wells are completed in Precambrian granite (the Burro Mountain Granite), in Tertiary quartz monzonite intrusive rocks, and in semi-consolidated deposits of the Tertiary-Quaternary Gila Conglomerate. Results of these tests are described below.

Precambrian Granite

The (New Mexico Bureau of Geology and Mineral Resources, 2005) describe the granite as a Mesoproterozoic megacrystic granitic plutonic rock. Trauger (1972) indicated that well yields in this type of rock are low, ranging from less than one gallon per minute (gpm) to 15 gpm; yields are dependent upon the degree of jointing and weathering of the dense crystalline rock. Table 1

contains results of tests performed by (Daniel B. Stephens and Associates (DBSA), unpubl, 2007) on two wells completed in the Burro Mountain Granite; results of these tests indicated the unit is moderately weathered and/or jointed at this location.

Tertiary Quartz Monzonite

Trauger (1972) indicated that the water-bearing potential of the Tertiary quartz monzonite is similar to that of the Precambrian granite. Table 1 contains results of 7 tests performed by (DBSA, unpubl, 2007) on wells completed in this unit. Aquifer properties ranged from very low permeability with low storage capacity to fairly conductive with moderate storage properties.

Tertiary-Quaternary Gila Conglomerate

The Gila Conglomerate is a water-bearing unit throughout much the lowland area of Grant County. Trauger (1972) describes this unit as conglomerate, fanglomerate, gravel, sand, silt, clay and lacustrine deposits, and is divided into an upper unconsolidated to semi-consolidated unit and a lower well-consolidated and locally-cemented unit. Trauger (1972) indicated that water yields range from less than 1 gpm to more than 2000 gpm and are dependent primarily upon texture and degree of consolidation of the unit. Exposures of Gila Conglomerate at Tyrone were identified by Trauger (1972) as upper Gila. Table 1 contains results of 13 tests performed by (DBSA, unpubl, 2007) on wells completed in the Gila. Water-bearing properties ranged from low to very high, with modest storage properties.

Fierro-Hanover Area

The Fierro-Hanover area is located approximately 10 km northeast of Bayard (Fig. 1). Tested wells are completed in the Ordovician-Silurian Fusselman and Montoya Dolomite, the Devonian Percha Shale, the Mississippian Lake Valley Limestone, Tertiary granodiorite porphyry of the Fierro-Hanover stock, and in unconsolidated Quaternary alluvium.

Fusselman-Montoya Dolomite

Jones et al. (1967) mapped the Montoya and Fusselman as a single unit in the Fierro-Hanover area, describing the unit as coarse-crystalline dolomitic cherty marble, crystalline limestone and dolomite. Trauger (1972) indicated that the Paleozoic carbonate rocks in Grant County are low permeability except where highly fractured and generally yield only modest quantities of water; yields of wells completed in carbonate rocks of Silurian and Ordovician age range in production from less than 1 gpm to 250 gpm. Table 1 contains results of 5 tests that were performed by (Telesto Solutions, Inc. (Telesto) unpubl, 2005) and (Golder Associates, Inc. (Golder), unpubl, 2006) on wells completed in the Fusselman-Montoya. Water-bearing properties obtained by tests indicate that the unit is generally impermeable and functionally non water-bearing except where fractured or weathered conditions exist.

Devonian Percha Shale

Jones et al. (1967) described the Percha Shale as a predominantly thin-bedded gray shale containing limy nodules; the texture and hardness of the shale varies from soft and erodible to hard where contact metamorphism has altered the shale to hornfels. Trauger (1972) described this unit as generally non water-bearing, with occasional exceptions where wells yield up to 1 gpm. Table 1 contains results of 5 tests that were performed by (Telesto, unpubl, 2005) and (Golder, unpubl, 2006) on wells completed in the Percha Shale. These tests indicated that the water-bearing potential was generally very low, with some notable exceptions where fractures and/or weathering were present.

Mississippian Lake Valley Limestone

Jones et al. (1967) described the Lake Valley Limestone as a massive white to pink crinoidal limestone in its upper part and darker cherty siliceous limestone in its lower part. Trauger (1972) described this unit as generally dense but locally water-bearing with well yields ranging from less than 1 gpm to about 180 gpm. Table 1 contains results of 3 tests that were performed by (Telesto, unpubl, 2005) and (Golder, unpubl, 2006) on wells completed in the Lake Valley Limestone. These tests indicated that water-bearing potential of this unit was generally very low.

Tertiary Hanover-Fierro Granodiorite Pluton

Jones et al. (1967) described the Hanover-Fierro pluton as primarily a medium-to-coarse hornblende-biotite granodiorite porphyry. Trauger (1972) grouped this unit with other Tertiary granitic intrusive rocks of the county and described the water-bearing potential of these types of rocks as low, with productive wells limited to areas of fracturing of otherwise impermeable rock. Table 1 contains results of 13 tests that were performed by Telesto (unpubl., 2005) and Golder (unpubl., 2006) on wells completed in the Hanover-Fierro granodiorite. These tests indicated that the water-bearing potential was generally very low.

Quaternary Alluvium

In the vicinity of Hanover-Fierro, alluvium deposits are limited to drainage bottoms; thickness is generally less than 15 meters. Trauger (1972) indicates that these deposits can be highly conductive and form prolific aquifers where associated with perennial streams. Table 1 contains results of 2 tests that were performed by Telesto (unpubl., 2005) on wells completed in the alluvium. These tests indicated that the alluvium has moderate to moderately-high water-bearing properties in the area.

Santa Rita Area

The Santa Rita area is located approximately 6 km east of Bayard (Fig. 1). Tested wells are completed in Pennsylvanian carbonates of the Oswaldo and Syrena Formations, Cretaceous shale and sandstone of the Colorado Formation and Beartooth

Quartzite, Cretaceous and Tertiary intrusives, including the Santa Rita stock, as well as Tertiary extrusives, including the Neeling Nun Rhyolite Tuff, the Rubio Peak rhyolite flows and basaltic andesite flows.

Pennsylvanian Oswaldo and Syrena Formations

Jones et al. (1967) described the Syrena and Oswaldo Formations as predominantly argillaceous limestone, interbedded with thin limey shale and sandstone beds. Trauger (1972) grouped the Oswaldo and Syrena Formations with the Lake Valley Limestone and described them as generally dense but locally water-bearing with well yields ranging from less than 1 gpm to about 180 gpm. Table 1 contains results of 7 tests that were performed by (Golder, unpubl, 1996 and 1999) and (Woodward-Clyde Inc. (WCI), unpubl, 1996) on wells completed in the Oswaldo or the Syrena Formations. These tests indicated that both of these units have particularly low water-bearing potential in the area.

Lower Cretaceous Beartooth Quartzite

Jones et al. (1967) described the Beartooth Quartzite as a reddish fine-grained orthoquartzite consisting of quartz sandstone that has typically been silicified to quartzite. Trauger (1972) grouped the Beartooth Quartzite with other dense lithified clastics of the Colorado Formation, indicating that all units have low water-bearing potential, with well yields ranging from less than 1/10 gpm to about 15 gpm. Table 1 contains results of 3 tests that were performed by (Golder, unpubl, 1996) on wells completed in the Beartooth Quartzite. These tests indicated that this unit has particularly low water-bearing potential in the area.

Upper Cretaceous Colorado Formation - Lower Shale and Upper Sandstone Members

Jones et al. (1967) divided the Colorado Formation into lower shale and upper sand members; the lower shale member is described as black, fissile, well-bedded shale; the upper sandy member consists of alternating beds of olive green to yellowish gray green shale and fine-to-coarse arkosic, cross-bedded sandstone, locally containing carbonized plant fragments. Trauger (1972) indicated that these units have low water-bearing potential. Table 1 contains results of 23 tests that were performed by (Golder, unpubl, 1990 and 1994) and by (WCI, unpubl, 1996) on wells completed in the lower shale member, or in undivided lower shale and upper sand members of the Colorado Formation. These tests indicated that the Colorado Formation has low water-bearing potential with a few exceptions where the unit is highly fractured.

Cretaceous quartz diorite porphyry and hornblende quartz diorite (sills, laccoliths)

Jones et al. (1967) identified more than 30 distinct varieties of intrusive that were dated in the interval between late Cretaceous(?) and Miocene(?). Trauger described these units as dense,

but locally water-bearing. Tests were conducted on 38 wells completed in Cretaceous quartz diorite porphyry and hornblende quartz diorite intrusive rocks by (Golder, unpubl, 1990, 1998 and 1999); summary data from these tests is presented in Table 1. Test results indicate that these rocks are generally tight and have very low water-bearing potential and low storage properties, except in relatively isolated areas where fracture-enhanced rocks are present.

Tertiary granodiorite porphyry (dikes)

Jones et al. (1967) identified a number of granodiorite porphyry dikes associated with the Santa Rita stock. These units were described by Trauger (1972) as dense, but locally water-bearing. Tests were performed on 2 wells completed in these units by (Golder, unpubl, 1994); results of these tests are listed in Table 1. Testing indicates that these units have very low water-bearing potential and low storage characteristics as well.

Tertiary Extrusive Rocks – Upper Rubio Peak Fm, Neeling Nun Tuff and Basaltic Andesite flows

Jones et al. (1967) described a complex of extrusive volcanic rocks in the area, ranging from earlier rhyolites and dacites, grading into basaltic andesite flows. The upper Rubio Peak Formation was described as two separate flows of massive, dark gray, slightly vesicular porphyritic rhyodacite, containing glassy feldspar and dark pyroxene, separated by a rubble-detrital zone. The Neeling Nun Rhyolite Tuff was described as a massive welded ash-flow tuff ranging in composition from rhyolite to quartz latite. The basaltic andesite was characterized as porphyritic, reddish gray in color, vesicular and brecciated. Trauger (1972) indicated that all of these units are locally water bearing, having modest well yields generally less than 5 gpm. Table 1 contains results of 41 tests that were performed by (Golder, unpubl, 1996) on wells completed in Tertiary extrusive volcanic rocks. The tests indicate that the Rubio Peak Formation and the Neeling Nun Tuff are generally dense and have low water-bearing properties; however these zones have significant potential where fractured or where clastic zones between flows may yield water. The basaltic andesite flows generally have higher water-bearing potential than the other Tertiary extrusive rocks.

Hurley Area

The Hurley area is located immediately east of the town of Hurley (Fig. 1). Tested wells are completed in Tertiary-Quaternary Gila Conglomerate.

Tertiary-Quaternary Gila Conglomerate

Pratt (1967) described the Gila Conglomerate in the vicinity of Hurley as poorly sorted, poorly to well consolidated coarse clastic deposits consisting of subangular detrital fragments weathered from adjacent highlands. Pratt identified three lithologic facies of the Gila Conglomerate in the Hurley area; a carbonate facies

approximately 5 miles west of Hurley containing erosional remnants derived from the Silver City Range and nearby Lone Mountain, a silicic facies approximately 7 miles southwest of Hurley containing materials derived from granitic porphyries of the Little Burro Mountains and a volcanic facies derived from the Pinos Altos and Cobre Mountains adjacent to the Hurley area. Pratt's observations of highly variable texture, sorting and lithology of the Gila are similar to those of Trauger (1972), who attributed the highly variable ground-water potential of the Gila to these factors. Table 1 contains summary results of 46 tests of wells completed in the upper Gila near Hurley that were performed by Trauger (1972), (Kennecott Minerals Company, unpubl, 1983; Dames and Moore, unpubl, 1983; Shomaker, unpubl., 1997 and 1998; and Golder, unpubl, 1999). The tests indicate that water-bearing potential of the upper Gila Conglomerate ranges from low to very high and is generally moderate; storage potentials are moderate. Comparison of Gila tests at the Hurley and Tyrone areas indicates that the Gila has greater water-bearing potential at Hurley than at Tyrone.

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