## 353. ANALYSES OF GAS AND WATER FROM TWO MINERAL SPRINGS IN THE COPPER RIVER BASIN, ALASKA

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Two gas and mineralized-water springs, previously reported by the authors (1961, p. 1076), were sampled during the summer of 1960. These springs, here termed the Copper Center and Tazlina mineral springs, issue from small mounds and thus may be classed as incipient mud volcanoes. Several other smaller springs, also presumably mineralized, have been seen from the air, but were not visited. All of the springs are in the southeastern Copper River Basin (fig. 353.1), and appear to be associated with mud volcanoes that have been divided into two general groups based on geographic distribution and chemical and physical characteristics. The Drum group (Shrub, Upper Klawasi, and Lower Klawasi mud volcanoes) lies east of the Copper River and has the largest cones, 150 to 310 feet high; its springs are characterized by carbon dioxide gas and warm sodium bicarbonate and sodium chloride waters. The Tolsona group (Nickel Creek, Shepard, Tolsona No. 1, and Tolsona No. 2 mud volcanoes) lies west of the Copper River and has cones 25 to 60 feet high; all but the inactive Shepard mud volcano have springs that discharge methane gas and cool sodium chloride and calcium chloride water.

East of the Copper River, thick glacial, lacustrine, and fluvial deposits mantle andesitic lavas of Tertiary to Recent age. West of the Copper River, marine sedimentary rocks of Cretaceous age, and semiconsolidated sandstone, conglomerate, and a few thin lignitic beds of Tertiary age, are overlain by Pleistocene deposits (Miller and others, 1959, p. 52, pl. 3).

### DESCRIPTION OF THE SPRINGS

The Copper Center mineral spring is 2½ miles N. 20° E. of Copper Center (fig. 353.1). It consists of

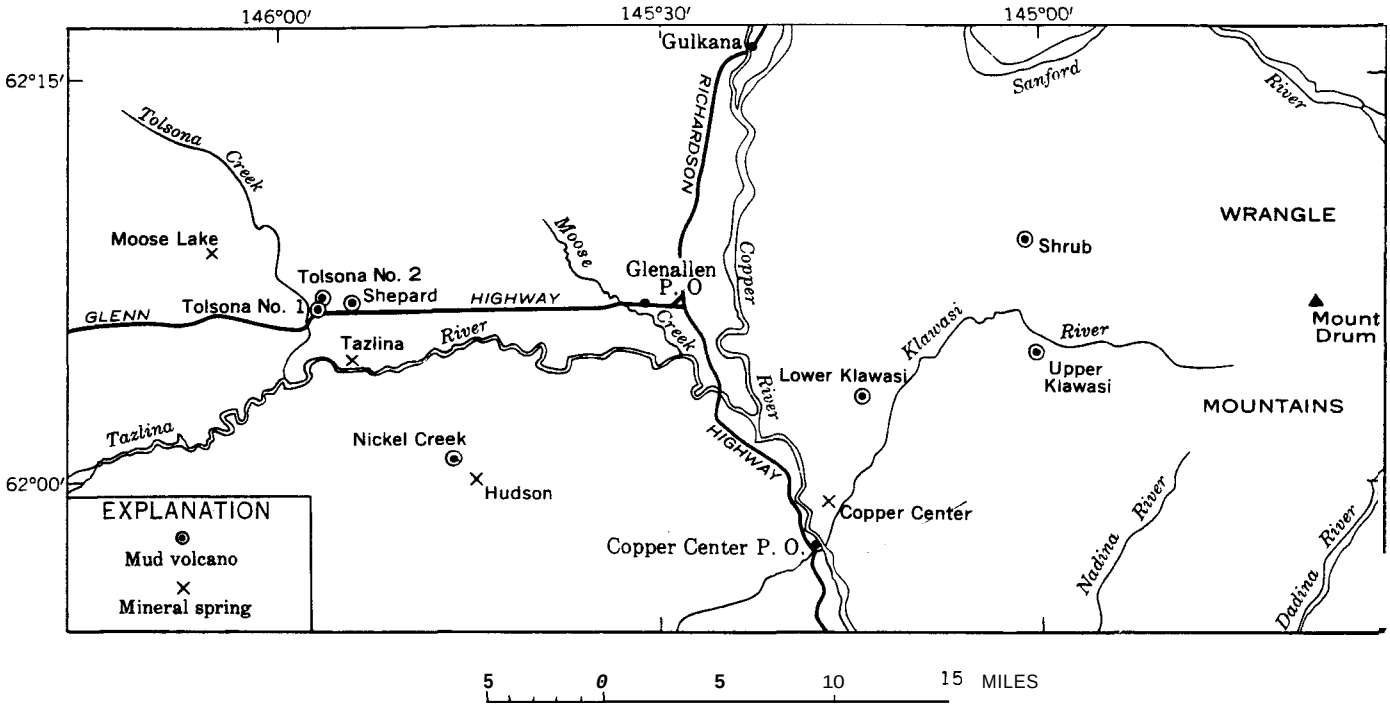


**FIGURE 353.1.—Location of principal mud volcanoes and mineral springs, Copper River Basin, Alaska.**

two vents, each 1½ inches wide, and a single pool 5 to 8 feet in diameter and 2 feet deep. The pool and vents lie on the eastern edge of a barren, almost imperceptible mound, the base of which is about 75 feet in diameter and about 1 foot below the nearby ground surface. The mound consists largely of pebbly clayey silt to a depth of at least 3½ feet. The bottom of the pool, however, is covered by medium to coarse sand. Coarse gravel, which lines the drainage channel from the spring, and twigs and sand in the pool are coated by an iridescent bluish-purple precipitate.

When observed, water in the pool was clear green and had a temperature of 63°F, 12° less than the air temperature but 15° to 25° more than ground-water temperature. Water from the pool discharged into a small stream at a rate of about 9 gpm, but sank into the stream bed within 300 yards. Discharge from the vents was insignificant. A dry, grass-covered drainage way, 50 to 500 feed wide, that extends southwestward from the spring to a gully incised in the bluffs of the Copper River suggests that discharge of water from the pools was much greater in the past. Gas bubbled intermittently from several places in the pool and from the two small vents.

The Tazlina mineral spring is in a clearing on a low terrace north of the Tazlina River, about 2½ miles east of Tolsona Creek. In this approximate area, Theodore Chapin, in 1914 (unpublished data), found a "circular area 15 feet across [with] over 50 mud volcanoes * * * [and with] mounds 4 to 5 feet high." The Tazlina spring, which may be the same as Chapin's mud volcanoes, presently consists of 4 pools 3 to 5 feet in diameter on a single grass-covered mound 3 to 4 feet high and 250 feet in diameter. The mound is composed of dark-gray clayey silt and fine sand. Gas bubbled intermittently from 3 of the 5 vents in the largest pool at the mound crest (fig. 353.2), but activity was very sporadic in the other 3 pools on the northeast slope of the mound. The water seeps into grass-covered marshes bordering the pools; the rate of discharge could not be measured. Gray, silt-laden water in the pools had a salty taste and a temperature of 40° F, close to that of the ground water but 35° lower than air temperature at the time measured.

## WATER AND GAS ANALYSES

Waters from the Copper Center and Tazlina mineral springs (table 353.1) are similar to waters of the Tolsona group of mud volcanoes (Nichols and Yehle, 1961, table 3); the principal difference is that the average of total dissolved solids of the Tolsona group is much lower than that of the Copper Center mineral spring and much higher than that of the Tazlina mineral spring. Waters from the Tolsona group also have an appreciably higher iron content. Both the spring and mud volcano waters are relatively low in bicarbonate and high in chloride and calcium in contrast to waters of the Drum group.

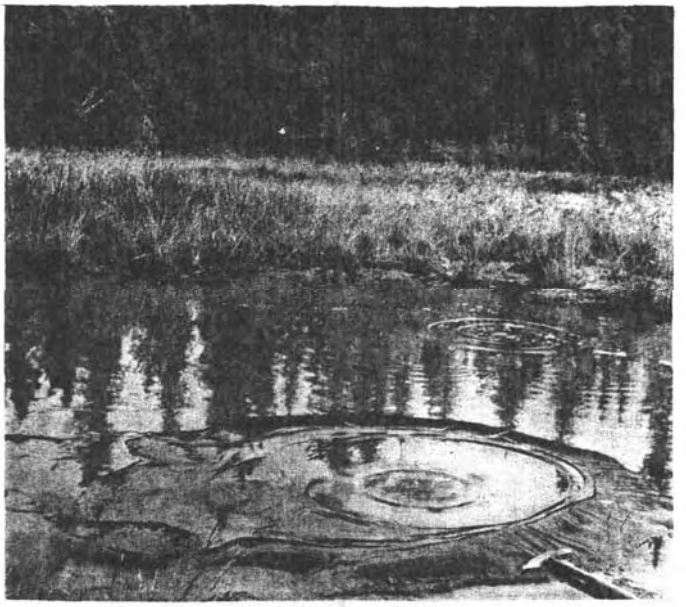

FIGURE 353.2.—Gas bubbling from 2 of 5 vents in pool at crest of Tazlina mineral spring.

TABLE 353.1.—*Analyses of water and ratios of chemical constituents in water from Copper Center and Tazlina mineral springs*

[Analyses by U.S. Geological Survey, Palmer, Alaska.]

| | Mined spring | |
|---|---|---|
| | Copper Center (Sample 6129 collected Aug. 7, 1960) | Tazlina (Sample 6131 collected Aug. 8, 1960) |
| Constituent (ppm): | | |
| $SiO_2$ | 24 | 24 |
| Fe | .0 | .03 |
| Ca | 3,060 | 909 |
| Mg | 24 | 48 |
| Na | 5,960 | 1,170 |
| K | 55 | 11 |
| Mn | .04 | .25 |
| $HCO_3$ | 124 | 216 |
| $SO_4$ | 4.0 | 3.5 |
| Cl | 14,400 | 3,400 |
| F | 1.7 | .3 |
| $PO_4$ | .05 | |
| Total dissolved solids (calculated) | 23,600 | 5,670 |
| Hardness as $CaCO_3$ | 7,730 | 2,470 |
| Non-carbonate | 7,630 | 2,290 |
| Specific conductance | 36,400 | 9,800 |
| Density | 1.017 | |
| pH | 8.0 | 7.3 |
| Ratio: | | |
| Ca/Na | .5134 | .7769 |
| Mg/Ca | .0078 | .0528 |
| K/Na | .0092 | .0094 |
| $HCO_3$/Cl | .0086 | .0635 |
| $SO_4$/Cl | .0003 | .0103 |
| F/Cl | .0001 | .0009 |

TABLE 353.2—*Analyses of gas from Copper Center and Tazlina mineral springs, and Tolsona No. 1 mud volcano*

[Mass spectrometer analyses by, and used with permission of, Helium Activity Laboratory, U.S. Bureau of Mines, Amarillo, Tex.; Tr. = trace, less than 0.05 percent]

| | Mineral springs | | Tolsona No. 1 mud volcano (Sample Y–0.287x, collected Aug. 29, 1960) |
|---|---|---|---|
| | Copper Center (Sample N–0.224d, collected Aug. 7, 1960) | Tazlina (Sample N–0.229, collected Aug. 8, 1960) | |
| Component (percent): | | | |
| Methane | 44.6 | 58.2 | 63.4 |
| Ethane | .0 | .0 | Tr. |
| Propane | .1 | .1 | .1 |
| n-butane | .0 | .0 | Tr. |
| i-butane | .0 | .0 | Tr. |
| n-pentane | .0 | .0 | .0 |
| i-pentane | .0 | .0 | .0 |
| Cyclo-pentane | Tr. | .0 | Tr. |
| Hexanes plus | Tr. | .0 | Tr. |
| Nitrogen | 55.0 | 40.4 | 35.9 |
| Oxygen | Tr. | .1 | .1 |
| Argon | .1 | .2 | .1 |
| Helium | Tr. | .1 | .1 |
| Hydrogen | .0 | .1 | .0 |
| Hydrogen sulfide | .0 | .0 | .0 |
| Carbon dioxide | .1 | .9 | .2 |
| Total | 99.9+ | 100.1 | 99.9+ |
| Sulfur odor | | | |
| Calculated total Btu | 454 | 592 | 645 |

Analyses of gas emanating from the Copper Center and Tazlina mineral springs and an analysis of gas from the Tolsona No. 1 mud volcano are presented in table 353.2. These analyses show a high methane and nitrogen content and closely resemble analyses of Tolsona group gases (Nichols and Yehle, 1961, table 2). This contrasts with the predominantly carbon dioxide gas emanating from the Drum group.

The Copper Center and Tazlina mineral springs are included in the Tolsona group of mud volcanoes because of the composition of their water, and especially of their gas. Comparison of the ratios of chemical constituents of the spring water with median ratios of chemical constituents of other waters of different types as reported by White (1960, p. B452) shows no striking similarities, and the source of the water issuing from the springs and mud volcanoes remains uncertain. However, the close similarity of gas from springs and mud volcanoes of the Tolsona group suggests that all have a common source, perhaps from buried Cenozoic marsh or coal deposits, or from porous nonpetroliferous beds of pre-Tertiary (Cretaceous?) age.

## REFERENCES

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Nichols, D. R., and Pehle, L. A., 1961, Mud volcanoes in the Copper River Basin, Alaska, in Geology of the Arctic: Toronto, Canada, Univ. of Toronto Press, p. 1063–1087.

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