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GEOLOGICAL SURVEY

A possible concealed pluton in Beaverhead and Madison Counties, Montana, and Clark County, Idaho

By

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This report is preliminary and has not been edited or reviewed for conformity with U.S. Geological Survey standards and nomenclature.

Contents

Illustrations

Tables

A POSSIBLE CONCEALED PLUTON IN BEAVERHEAD AND

MADISON COUNTIES, MONTANA, AND CLARK COUNTY, IDAHO

By

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Abstract

A northeast-trending magnetic anomaly in parts of Beaverhead and Madison Counties, Mont., and Clark County, Idaho, may reflect the trend, shape, and size of a concealed pluton. The type of rock that forms the pluton(?) is unknown. A small volcanic pipe, possibly a diatreme, is at the southeast end of the high. The pipe, about 92 m (300 ft) in diameter, consists of a rubbly basalt-like matrix through which are scattered xenoliths of Precambrian crystalline rocks and of various Paleozoic and Mesozoic strata. It is uncertain whether the juxtaposition of the pipe and the magnetic high is meaningful or is merely fortuitous. Although no mineralized rock was found in the area underlain by the anomaly, placer gold has been found nearby. Some 113 km (70 mi) to the west, in Custer and Lemhi Counties, Idaho, a similar northeast-trending magnetic high marks the site of the Gilmore mining district. The similarities in trend, shape, and magnitude between the two anomalies suggest that the high in Beaverhead and Madison Counties should be investigated for undetected mineral deposits, possibly by a geochemical survey.

An aeromagnetic survey of southeastern Idaho and southwestern Montana (U.S. Geological Survey, 1972) has disclosed an unusually large magnetic high that cuts across the major structural features of the Centennial area, Beaverhead and Madison Counties, Mont., and Clark County, Idaho (Figs. 1, 2A). The anomaly trends about N. 35° E. and forms an angle of about 60° with both the eastward-trending Centennial Mountains-Centennial Valley structural pair and the northwest-trending Madison Range-Madison Valley pair. The high is about 40 km (25 mi) long and 16 km (10 mi) wide, and has a magnetic relief of about 120 gammas.

I suspect that this high reflects the trend, shape, and size of a concealed pluton. The type of rock that forms the pluton(?) is unknown. A small volcanic pipe, possibly a diatreme, is along the southeast edge of the high and may be the result of leakage from the buried pluton(?). There is, however, no convincing evidence to substantiate any relation between the pipe and the pluton(?), and their juxtaposition may be fortuitous.

The pipe is exposed along the crest of the eastern part of the Centennial Mountains, where it crops out as a mass of dark-gray to black rubbly rock about 92 m (300 ft) in diameter in the center of sec. 1, T. 15 S., R. 1 W. It is clearly intrusive for it cuts both the basement complex of Precambrian crystalline rocks and the overlying bedded sedimentary strata; it seems to represent the upper end of an upward-punching igneous plug. The rubbly material that forms the pipe breaks apart easily and, thus, the pipe lacks topographic relief; it conforms to the contours of the adjacent terrain.

The pipe is composed of two kinds of material: a dark-gray to black fine-grained basaltlike matrix, and a chaotic mixture of metamorphic, sedimentary, and igneous xenoliths. The matrix consists of a pilotaxitic mixture of plagioclase microlites through which are scattered small, euhedral to subhedral pyroxene grains and some magnetite. A light brown glass fills the spaces between the microlites. Phenocrysts of euhedral to subhedral clinopyroxene (salite, $2V_Z \sim 58°$, $n_y = 1.690$) are common; less abundant are plagioclase laths of labradorite (An_{53}). Both the pyroxene and plagioclase phenocrysts are zoned. No olivine was noted although several voids have suggestive olivine shapes. Many of the vesicles and voids are rimmed by light-green chalcedony; the centers of these vesicles are filled with carbonate. Xenocrysts of subround quartz and sedimentary chert(?) are common. This basalt is similar to the basalt that forms the dikes and sills exposed farther to the west in the western Centennial Mountains.

Table 1 compares the abundance of elements in the pipe's basalt matrix with those listed by Turekian and Wedepohl (1961, table 2) for other basaltic rocks. In general, the basalt of the pipe has a lower titanium content, but larger amounts of barium and strontium. This predominance of barium and strontium seemingly is a characteristic of many of the mafic alkaline-rich rocks of this part of southwestern Montana (Hamilton and Leopold, 1962, p. B-28).

The xenoliths include subangular to angular cobbles and small boulders of Precambrian crystalline rocks such as dark-gray amphibolite, light-brown dolomite, white and light-green quartzite, and brown mica schist. These rocks are identical to the Precambrian crystalline rocks that form the basement in this part of southwestern Montana. Many of the xenoliths are sedimentary clasts of Paleozoic and Mesozoic age; the following formations are represented: Madison Group (Mississippian), Amsden Formation (Pennsylvanian), Quadrant Sandstone (Pennsylvanian), Dinwoody(?) Formation (Triassic), and Aspen(?) Formation (Cretaceous). Some xenoliths are fragments of pyroxene trachyte porphyry, a mafic volcanic rock that makes up the bulk of nearby Sawtell Peak. This trachyte is tentatively considered as Eocene in age (Witkind, 1972), and the trachyte xenoliths imply that the pipe was emplaced at some time after the Eocene.

The youngest layered sedimentary rocks intruded by the pipe are light-gray dolomite beds of the Amsden Formation (Pennsylvanian), but nearby is a small patch of bright cherry-red siltstone and sandstone beds which is unrelated to any of the sedimentary rocks exposed in the general area. These red beds, resting unconformably on the Amsden, may be part of the Beaverhead Formation (Honkala, 1953) of Paleocene-Cretaceous age (Ryder and Scholten, 1973), or they may be intensely baked and altered beds of the Aspen Formation of Cretaceous age. If they are part of the Beaverhead Formation they are all that is left of what must have been an extensive cover, for comparable beds are not known in the eastern Centennial Mountains. Conversely, if they are part of the Aspen Formation they must have been baked and altered during the intrusion of the volcanic pipe and then let down thousands of metres vertically with little or no disruption.

Although no mineralized rock was found in the area underlain by the Centennial anomaly, some placer gold was found near Lakeview (Fig. 2A). Lyden (1948, p. 10) stated: "The production of 9.43 ounces of placer gold was reported from Lakeview on Odell Creek in 1935." The source of this placer gold is uncertain; although it may have come from various igneous intrusions in the Centennial Mountains, there is a strong possibility that it came from extensive glacial deposits that once mantled this area.

Some 113 km (70 mi) to the west, in Custer and Lemhi Counties, Idaho, a similar magnetic anomaly, also striking northeast, cuts across the Lemhi Range, here trending about N. 35° W. (Figs. 1, 2B). This magnetic high trends about N. 50° E., is about 17 km (10.5 mi) long and about 10 km (6 mi) wide, and has a magnetic relief of about 140 gammas. The high marks the site of the Gilmore mining district, from which lead, zinc, and silver have been extracted. The igneous rocks in the Gilmore mining district are quartz diorite and granodiorite; these rocks are closely related genetically to the ore deposits (Ruppel and others, 1970, p. 14 and 15).

Both anomalies cut across the regional structure, implying that they may be related. But there are some major uncertainties when the anomalies are compared, chiefly as to the kind of rock responsible for the Centennial high. It may be a basalt somewhat like that which forms the diatreme(?), thus differing sharply from the intermediate-type rocks responsible for the Lemhi anomaly. Despite this possibility, the similarities between the anomalies in trend, and to some extent in shape and magnitude, are marked. This likeness between these two widely separated anomalies suggests to me that the area underlain by the Centennial anomaly should be searched in more detail for as yet undetected mineral deposits. Such a concealed igneous body(?) may contain mineralized rock; the potential seems sufficient to justify a geochemical survey.

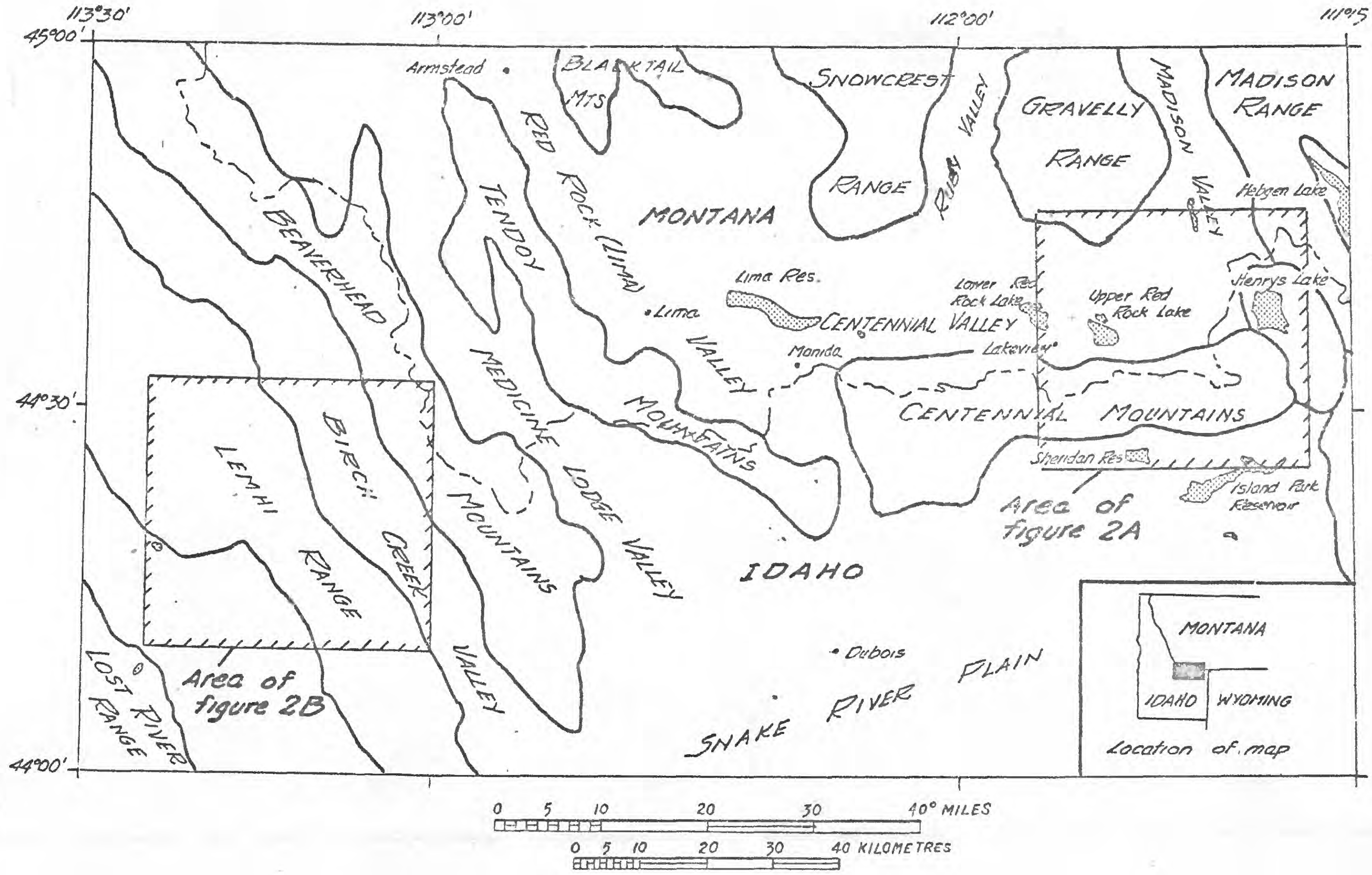
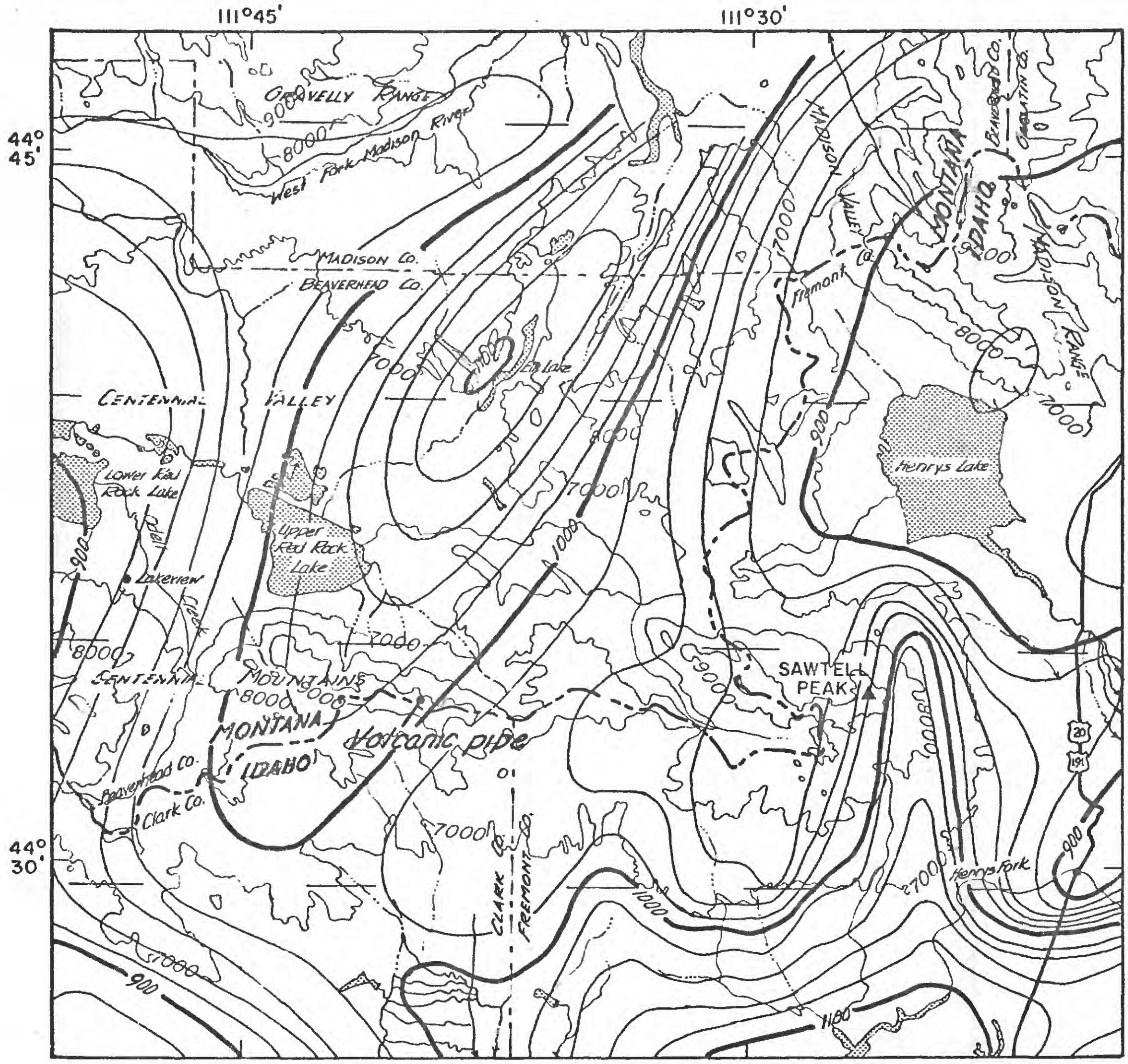


Figure 1.--Major physiographic features in parts of southeast Idaho and southwest Montana. Locations of figures 2A and 2B outlined by hachures.



A--Centennial magnetic high

0 5 10 MILES
0 5 10 KILOMETRES
Contour interval 1,000 feet

EXPLANATION

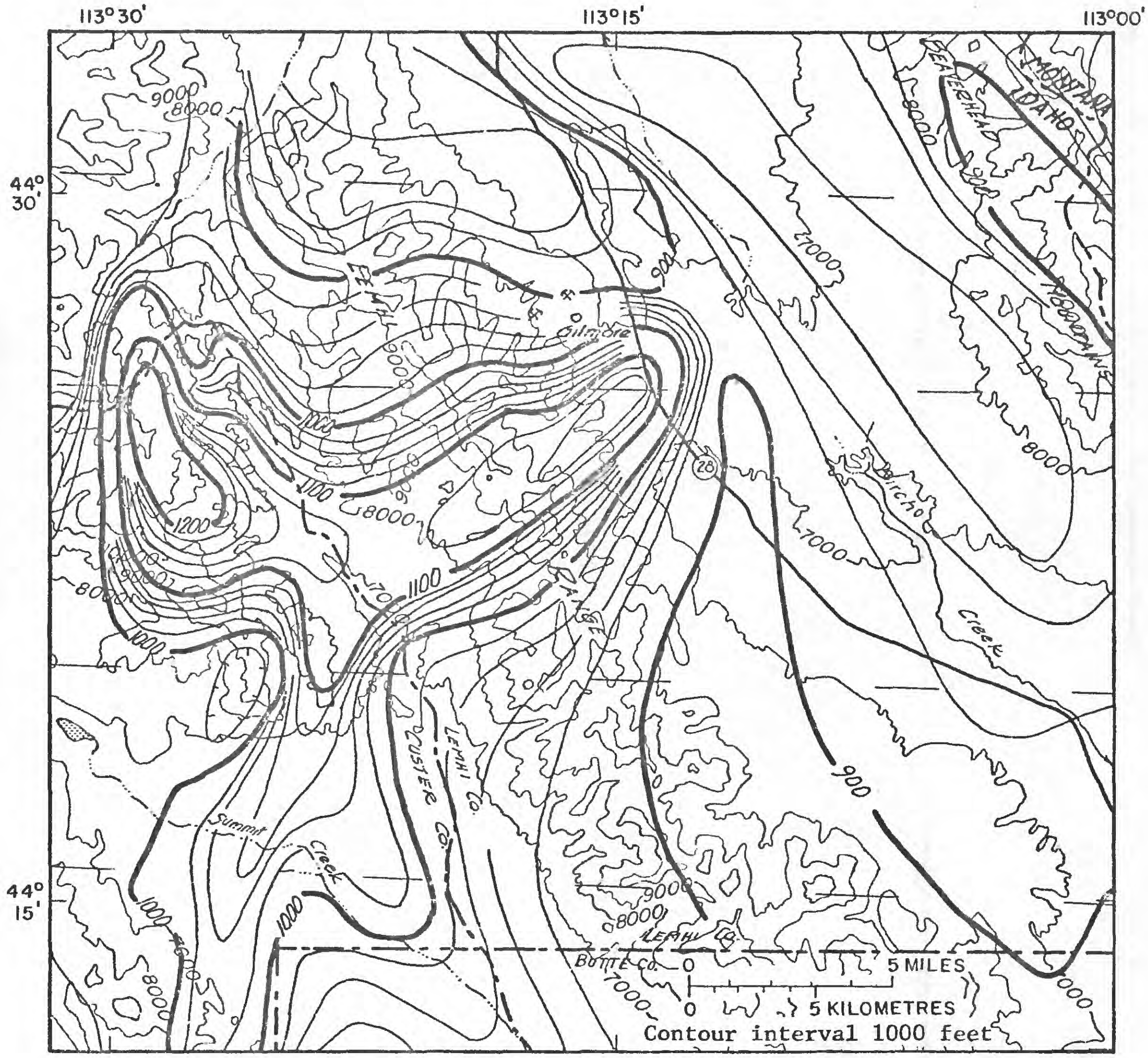
1000

Magnetic contours--Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum. Main magnetic field of the earth, from Fabiano and Peddie (1969), has been removed. Hachures indicate closed areas of lower magnetic intensity. Contour interval 20 gammas

Flight path--Showing location and spacing of data

Figure 2.--Two similar magnetic highs disclosed by an aeromagnetic survey of southeastern Idaho and southwestern Montana completed by the U.S. Geological Survey (1972). Aeromagnetic survey flown and compiled by U.S. Geological Survey. Flown at 3,810 m (12,500 ft) above sea level, 1969-71.

A, Northeast-trending magnetic high that cuts across the eastward-trending Centennial Mountains-Centennial Valley structural pair and the northwest-trending Madison Range-Madison Valley pair, Madison and Beaverhead Counties, Mont., and Clark County, Idaho.



B--Lemhi magnetic high

EXPLANATION

Magnetic contours--Showing total intensity magnetic field of the earth in gammas relative to arbitrary datum. Main magnetic field of the earth, from Fabiano and Peddie (1969), has been removed. Hachures indicated closed areas of lower magnetic intensity. Contour interval 20 gammas

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B, Northeast-trending magnetic high that cuts across northwest-trending Lemhi Range, Custer and Lemhi Counties, Idaho. This high may be related to ore deposition in the Gilmore mining district. The north-trending high in northwestern Custer County is probably due to Challis Volcanics.

Table 1.--Comparison of abundance of elements, in parts per million (ppm), of the pipe's basalt matrix with amounts determined by Turekian and Wedepohl (1961, table 2) for other basaltic rocks

[Semiquantitative 6-step spectrographic analysis by M. W. Solt, U.S. Geological Survey. D, "The data for these elements are missing or unreliable" (Turekian and Wedepohl, 1961, table 2). L, Detected but below limit of determination. N, Not detected at limit of detection]

ELEMENT	SYMBOL	BASALT MATRIX OF PIPE[1]	TUREKIAN AND WEDEPOHL (1961) BASALTIC ROCKS
		MAJOR ELEMENTS	
Silicon	Si	> 100,000	230,000
Aluminum	Al	100,000	78,000
Iron	Fe	70,000	86,500
Magnesium	Mg	50,000	46,000
Calcium	Ca	100,000	76,000
Sodium	Na	10,000	18,000
Potassium	K	7,000	8,300
		MINOR AND TRACE ELEMENTS	
Silver	Ag	N	0.11
Arsenic	As	N	2
Gold	Au	N	0.004
Baron	B	N	5.0
Barium	Ba	1,000	330
Beryllium	Be	L	1.0
Cadmium	Cd	N	0.22
Cerium	Ce	L	48
Cobalt	Co	30	48
Chromium	Cr	300	170
Copper	Cu	50	87
Gallium	Ga	15	17
Lanthanum	La	L	15
Manganese	Mn	1,000	1,500
Molybdenum	Mo	N	1.5
Niobium	Nb	15	19
Nickel	Ni	100	130
Phosphorus	P	N	1,100
Lead	Pb	N	6
Palladium	Pd	N	0.002
Platinum	Pt	N	D
Antimony	Sb	N	0.2
Scandium	Sc	15	30
Tin	Sn	N	1.5
Strontium	Sr	1,000	465
Tellurium	Te	N	D
Uranium	U	N	1.0
Vanadium	V	150	250
Tungsten	W	N	0.7
Yttrium	Y	15	21
Zinc	Zn	N	105
Zirconium	Zr	100	140

[1]Field No. CR-37a; laboratory No. 74DS-177.

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