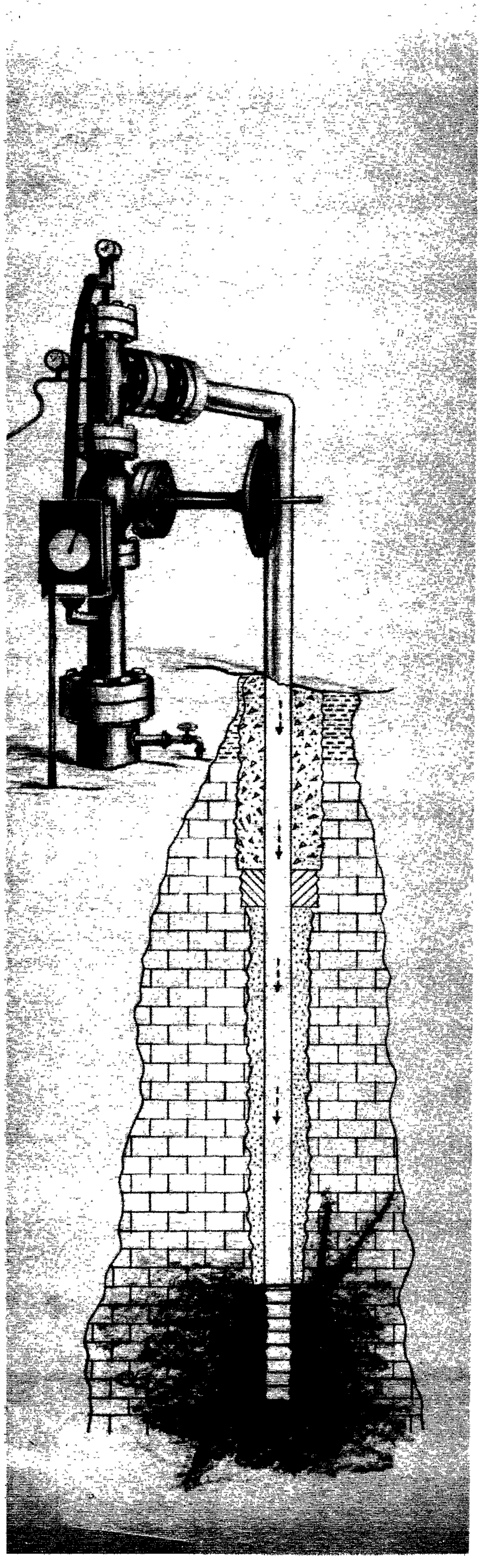

WATER-RESOURCES INVESTIGATIONS REPORT 85-4303

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PRELIMINARY EVALUATION OF THE BASAL SANDSTONE IN TENNESSEE FOR RECEIVING INJECTED WASTES

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U.S. GEOLOGICAL SURVEY
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By Dolores Mulderink and Michael W. Bradley

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Nashville, Tennessee
1986

UNITED STATES DEPARTMENT OF THE INTERIOR

DONALD PAUL HODEL, Secretary

GEOLOGICAL SURVEY

Dallas L. Peck, Director

For additional information
write to:

District Chief
U.S. Geological Survey
A-413 Federal Building
U.S. Courthouse
Nashville, Tennessee 37203

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FACTORS FOR CONVERTING INCH-POUND UNITS TO INTERNATIONAL SYSTEM OF UNITS (SI)

For the convenience of readers who may want to use the International System of Units (SI), the data may be converted by using the following factors:

Multiply	By	To obtain
inch (in.)	25.4	millimeter (mm)
foot (ft)	0.3048	meter (m)
foot per mile (ft/mi)	0.1894	meter per kilometer (m/km)
mile (mi)	1.609	kilometer (km)
square mile (mi^2)	2.590	square kilometer (km^2)
gallon per minute (gal/min)	0.00006309	cubic meter per second (m^3/s)

<u>National Geodetic Vertical Datum of 1929 (NGVD of 1929)</u>: A geodetic datum derived from a general adjustment of the first-order level nets of both the United States and Canada, formerly called mean sea level. NGVD of 1929 is referred to as sea level in the text of this report.

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ABSTRACT

The U.S. Environmental Protection Agency is authorized, under the Safe Drinking Water Act, to administer the Underground Injection Control program. This program allows for the regulation of deep-well disposal of wastes and establishes criteria to protect underground sources of drinking water from contamination.

The basal sandstone in Tennessee occurs west of the Valley and Ridge province at depths of 5,000 to 9,000 feet below land surface. The basal sandstone consists of about 30 to 750 feet of Cambrian sandstone overlying the crystalline basement complex. The basal sandstone is overlain and confined by shale and carbonate rocks of the Middle and Upper Cambrian Conasauga Group.

Hydrologic data for the basal sandstone, available from only three sites (four wells) in Tennessee, indicate that the basal sandstone generally has low porosity and permeability with a few zones having enough permeability to accept injected fluids. Limited water-quality data indicate the basal sandstone contains water with dissolved-solids concentrations exceeding 10,000 milligrams per liter. Since the dissolved-solids concentrations exceed 10,000 milligrams per liter, the basal sandstone is not classified as an underground source of drinking water according to U.S. Environmental Protection Agency regulations.

INTRODUCTION

Part C of the Safe Drinking Water Act (Public Law 93-523) authorized the U.S. Environmental Protection Agency (EPA) to establish regulations to assure that the underground injection of waste will not endanger existing or potential sources of drinking water. In order to regulate underground injection, EPA needs to identify and protect aquifers that are or can be used as drinking-water sources and to identify the aquifers or parts of aquifers that are not suitable as drinking-water sources.

Under part 146.04 of the Federal Underground Injection Control program (U.S. Environmental Protection Agency, 1981), an underground source of drinking water is protected from receiving injected wastes. However, EPA may exempt an aquifer or part of an aquifer and allow the injection of wastes if:

(A) It does not currently serve as a source of drinking water; and

(B) It cannot now, and will not in the future, serve as a source of drinking water because:
   (1) It is mineral, hydrocarbon, or geothermal-energy producing;
   (2) It is situated at a depth or location which makes recovery of water for drinking-water purposes economically or technologically impractical;
   (3) It is so contaminated that it would be economically or technologically impractical to render that water fit for human consumption; or
   (4) It is located over a class III well-mining area subject to subsidence or catastrophic collapse; or

(C) The total dissolved-solids content of the ground water is more than 3,000 and less than 10,000 mg/L (milligrams per liter), and it is not reasonably expected to supply a public water system.

An underground source of drinking water is defined in part 146.03 of the Underground Injection Control program as an aquifer which supplies water for human consumption, contains water with less than 10,000 milligrams per liter "total dissolved solids," and is not an exempted aquifer (EPA, 1981).

Under current technology and present economic conditions, it will be considered impractical to recover drinking water from an aquifer: (1) that contains water of inferior quality to existing, alternate sources of drinking water; (2) where treatment to make it potable would be uneconomical; and (3) where the aquifer lies below a source of drinking water that is adequate to supply present and future needs. A dissolved-solids concentration of 10,000 mg/L will be considered the limit above which demineralization would be uneconomical.

The purpose of this study is to identify areas in the basal sandstone that, under the State and Federal (EPA) Underground Injection Control programs, may be used for waste injection. Generalizations on hydrology and water quality have been made because data are limited.

GEOHYDROLOGY

The basal sandstone of Cambrian age occurs throughout the western two-thirds of Tennessee (fig. 1) and lies between the Conasauga Group and Precambrian basement (table 1). There are only 14 wells known to penetrate the basal sandstone in Tennessee (table 2; fig. 1).

The basal sandstone, ranging from 30 to more than 700 feet in thickness, is primarily sandstone with minor amounts of carbonate rocks. Hydrologic data from the basal sandstone are available from three wells in Maury County and one well in Humphreys County (fig. 1). Data from these wells indicate that the basal sandstone is dense and has low porosity and permeability. There are, however, a few zones with sufficient permeability to accept injected fluids. There are no water-level data available for the basal sandstone.

The Conasauga Group, the upper confining layer, consists of shale and shaley carbonate rocks (fig. 2). The Conasauga confining bed has very low permeability according to the few data available from injection tests (Warner, 1972; Geraghty and Miller, 1978). The underlying Precambrian basement is composed of granitic rock. Because of the extreme depth, it is assumed that there is very little effective porosity or permeability underlying the upper weathered zone.

EVALUATION OF THE BASAL SANDSTONE

The basal sandstone is not used to supply drinking water. The concentration of dissolved solids in water from four wells in the basal sandstone exceeds 10,000 mg/L (fig. 1). Based on water conductivity estimated from geophysical logs and water-quality data from other wells, the concentration of dissolved solids in water from the basal sandstone probably exceeds 10,000 mg/L throughout the area of occurrence. The basal sandstone does not qualify as an underground source of drinking water according to EPA criteria because of the high concentration of dissolved solids. Additionally, it is considered economically impractical to develop drinking-water supplies because of the depth, more than a mile below land surface. Potable water is abundant in the overlying aquifers.

Contamination of the basal sandstone is documented at three sites in Tennessee (table 3; fig. 1). Deep injection wells in Humphreys and Maury Counties have been used to inject wastes into zones that include the basal sandstone. Contamination is believed to be localized near the injection sites due to the low permeability of the formations.

CONCLUSIONS

The basal sandstone in Tennessee does not meet the EPA definition of an underground source of drinking water and does not need to be exempted from protection to receive injected wastes. Potable water is available from overlying aquifers at considerably shallower depths. Vertical flow between the basal sandstone and any overlying aquifers is believed to be very limited because of the hydrologic characteristics of the Conasauga confining bed. These conclusions are based on limited hydrologic data; additional data are needed to define adequately the hydrogeology and water quality of the basal sandstone.

Table 1.--Geologic units of the basal sandstone and confining layers

System	Series	Stratigraphic unit	Hydrology
Cambrian	Upper and Middle Cambrian	Conasauga Group	Low permeability; shale and carbonate rocks. Confining layer.
	Lower Cambrian	Unnamed basal sandstone	Some areas of higher permeability; but generally low.
Precambrian		Precambrian basement complex, crystalline rocks	Very low permeability and porosity. Confining layer.

Modified from Miller, 1974.

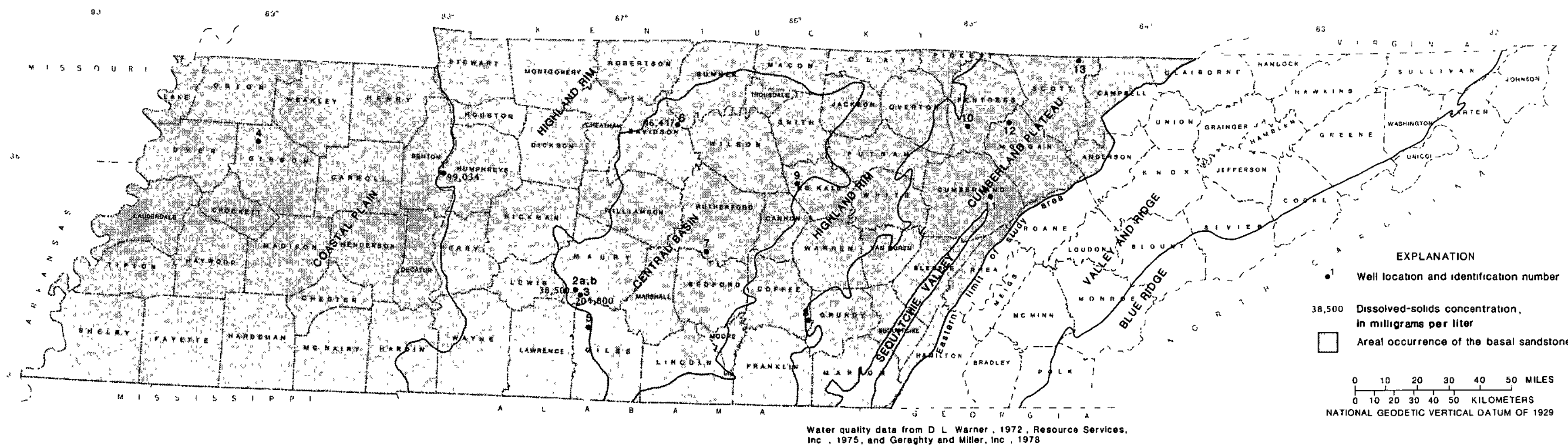


Figure 1.-- Areal occurrence, well location, and concentration of dissolved solids in the basal sandstone.

Table 2.--Wells in the basal sandstone

[Well records are on file with the Tennessee Division of Geology, Nashville, Tennessee; land surface altitude is National Geodetic Vertical Datum of 1929; NP, Not penetrated]

Well No.	Name	County	Land surface altitude, in feet	Depth to top of basal sandstone, in feet below land surface	Depth to top of Precambrian basement, in feet below land surface
1	DuPont, New Johnsonville Fee No. 2	Humphreys	384	7210	7,450
2a	Stauffer Chem. Co. Fee (disposal) No. 1	Maury	637	6300	6,400
2b	Stauffer Chem. Co. Fee No. 2	Maury	658	6330	6,420
3	Mobil Chemical Fee No. 1	Maury	720	6328	6,403
4	Big Chief H. H. Taylor No. 1	Gibson	381	6854	6,935
5	California Co. E. W. Beelar No. 1	Giles	814	5570	5,640
6	DuPont, Old Hickory Plant Fee No. 1	Davidson	498	5270	5,460
7	Gordon Street Inc. R. Holden No. 1	Rutherford	690	5530	5,560
8	Amoco Prod. Co. J. J. Brothers No. 1	Coffee	1059	5654	NP
9	Amoco Prod. Co. R. S. Driver No. 1	DeKalb	768	5045	5,445
10	Monitor Petroleum Gernt Est. No. 8	Fentress	1741	6980	7,744
11	Ladd Petroleum Co. T. J. Kemmer No. 1	Cumberland	2345	9960	10,110
12	Ed Riley Oil Co. Louise Lanham No. 1	Morgan	1475	7485	NP
13	Atha and Indiana Farm Bureau Ketchen Coal Co. No. 1	Scott	1169	7395	NP

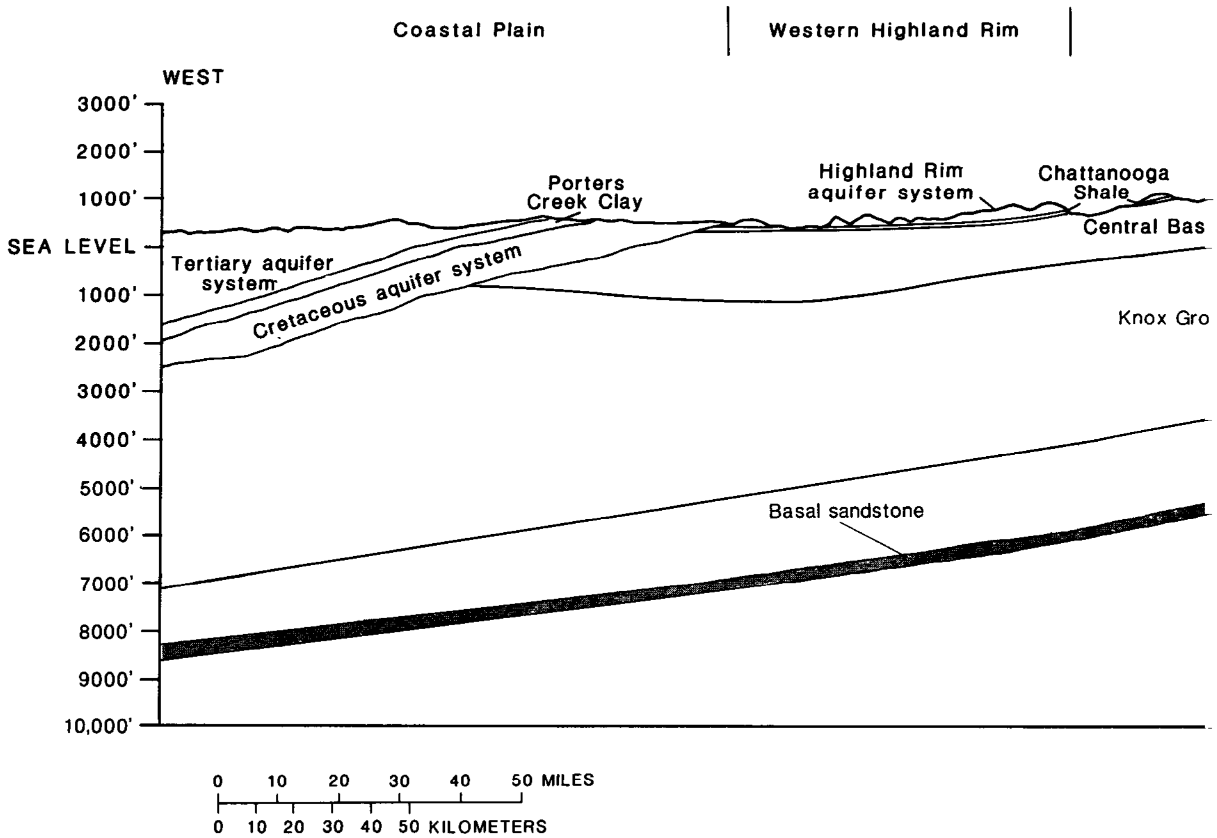
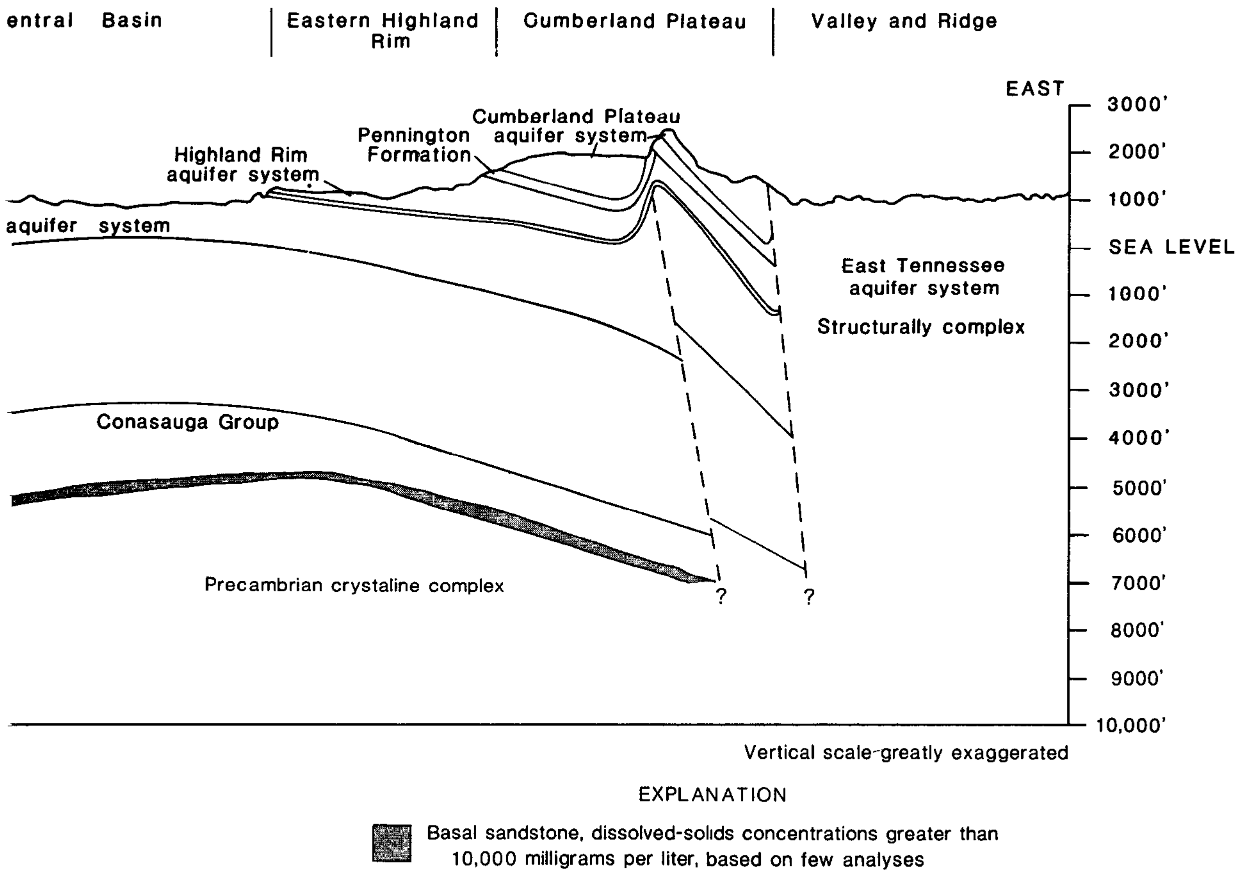


Figure 2.--Generalized hydrogeologic sectior



showing water quality in the basal sandstone.

Table 3.--Contamination sites in the basal sandstone

Site identification No.	Location	Type of contamination	Data source	Stratigraphic interval contamination	Comments
1	New Johnsonville, Humphreys County.	Industrial wastes, deep-well injection.	Warner, 1972	Injection zone extends from the lower Knox through the Conasauga and the basal sandstone aquifer to the Precambrian crystalline complex.	Contamination in 1972 extended laterally 4,000 feet. The injected wastewater is primarily composed of iron chlorides with pH of less than 1.
2	Mount Pleasant, Maury County.	Industrial wastes, deep-well injection.	Resource Services, Incorporated, 1975.	do	Extent of contamination unknown.
3	Mount Pleasant, Maury County.	Industrial wastes, deep-well injection.	Tennessee Division of Geology, unpublished data.	do	Injected waste is process wastewater, primarily sodium chloride. Extent of contamination to aquifer unknown.

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