Geostatistical Evaluation of the Sampling for Oil Total Hydrocarbons (OTH) in marshy zone of Alejandrina Area in Veracruz State, México.

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ABSTRACT

Geology in studied area nearby swampy zone of Alejandrina refinery varies from mudstone, eolic and debris from Miocene to Quaternary. Soil is CH type as soil mechanics classification with high compressibility. Thickness of soil observed can reach 15 meters in some sites.
We carried out two surveys with 37 samples of HTP (Total Hydrocarbons). One in surface and other 50 centimeters deep. Variograms calculated in surface with distance of 100 meters between samples reported an associated variance or 23 and for samples at 50 centimeters in deep 21 in four orthogonal directions (East-West, North-South, North-East-South-West and South-West-North-East). The site was modeled as a lognormal distribution.
Join Spatial Correlation of HTP was determined for surface survey with 11.36 mean value meanwhile for 50 centimeters deep survey reported 9.53. Using the geo-statistics tool of Cokriging correlation between grids in surface and in deep in separated samples having as a conclusion that for 50 centimeters in deep, only 34% of contamination drop in surface reached such depth.
In future studies we propose to estimate seismic risk in a 100 km radius area, due to the historical earthquake of 5.2 º in Richter scale. This will help to estimate risk maps and wave acceleration in the area.

Discussion

best sampling method for mapping surveyed variables in the field, is
onalization of stochastic variable, where each sample is related to a de
ribution function (Matheron, 1971; Hass and Viallix, 1976; Urrutia an
5; Flores, 1997; Hernández Quintero, 2001) and its spatial dependenc
essed as a variogram, where the mapped variable represents the space
ples in the highest direction change rate. Geochemical exploration of
urface was carried out in a 2 X 2 km^2 area. Oil spill of refinery were sa
most contaminated sites. Such survey considered 37 samples of Total
oleum Hydrocarbons (TPH) with a sample mean of 11.36 ppm, a varia
9 ppm^2, variance coefficient (V.C.) of 0.281, with 3 ppm as the lowes
666 000 ppm as the highest.
spatial distribution functions associated to surface sampling are log-n
, figured out from the 37 field samples (Figure 3). The associated vari
simulated in the four orthogonal directions (East-West; North-South;
theast-Southwest; and Northwest-Southeast). Consequently the variog
ulated for TPH is of Spherical type: (h) = 11+ 12 (1.5(h/200) – 0.5(
200 m and h 200 m. The variogram that drives this phenomenon
+ 12 = 23 ppm^2 (Figure 4). It is possible to recognize in NE-SW direc
ial periodical oscillations with 95 m mean wavelength. The map for sp
ribution of TPH shows a series of high values of 200 000 ppm oriente
direction (Figure 4).
e topographic coordinates as in the last survey were taken for this par
h of 50 cm, with 37 samples and with a muestral mean of 9.53 ppm, v
3.58 ppm^2, the variance coefficient (V.C.) is 0.386, a minimum of 2 p
000 ppm as a maximum. The spatial distribution function is log-norm
associated variogram is spherical (h) = 7.5+ 16 (1.5(h/200) – 0.5(h/2
200 m and h 200 m; variogram is (h)=7.5+ 16 = 23.5 ppm^2 (Figure
irections of the variogram show periodic spatial oscillations with 45 r
elength. In the TPH spatial distribution map it is possible to see highs
ppm oriented NW-SE (Figure 6).

Conclusions

We found that the mean value for the 37 samples of TPH in surface is 11.36 ppm, a variance of 10.19 ppm^2, a variance coefficient of 0.281, a minimum value of 3 ppm and a maximum of 666 000 ppm. Meanwhile for 50 cm depth, mean value is 9.53 ppm, variance is 13.58 ppm^2, and c.v. is 0.386. Minimum value is 2 ppm and maximum is 551 000 ppm.
As a first approach for the geostatistical model of Santa Alejandrina area we found that the relationship between two depths in hydrocarbons infiltration result of 1 to 34.24 1.11. This means that of 100% of spilled hydrocarbons in surface, only 34% reaches the 50 cm of depth of muddy soil in the sampled areas acting like a molecular filter.

We recommend further analysis in order to reach more detailed results. It is important to figure out the distribution coefficient Kd (in laboratory) to stablish hydrocarbons migration in porous media and forecasting balance of solid and liquid phases in clays. This would permit to know a delay coefficient to introduce in the diffusion equation and forecasting travel time of hydrocarbons likewise the mass percentage at 1, 2 and 3 m of depth in porous media (Flores et al., 2000).

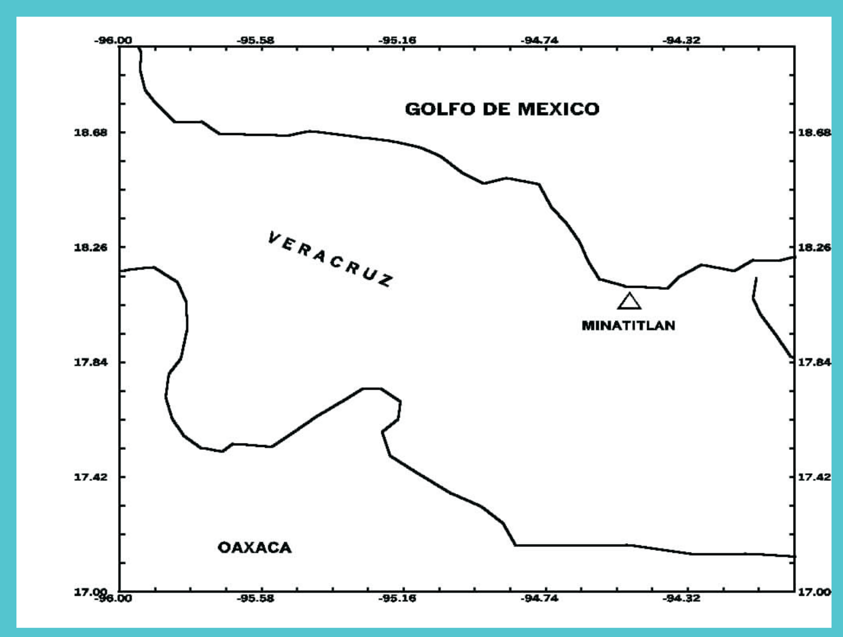

Figure 1. Refinery location map "Lázaro Cárdenas " Veracruz (México)

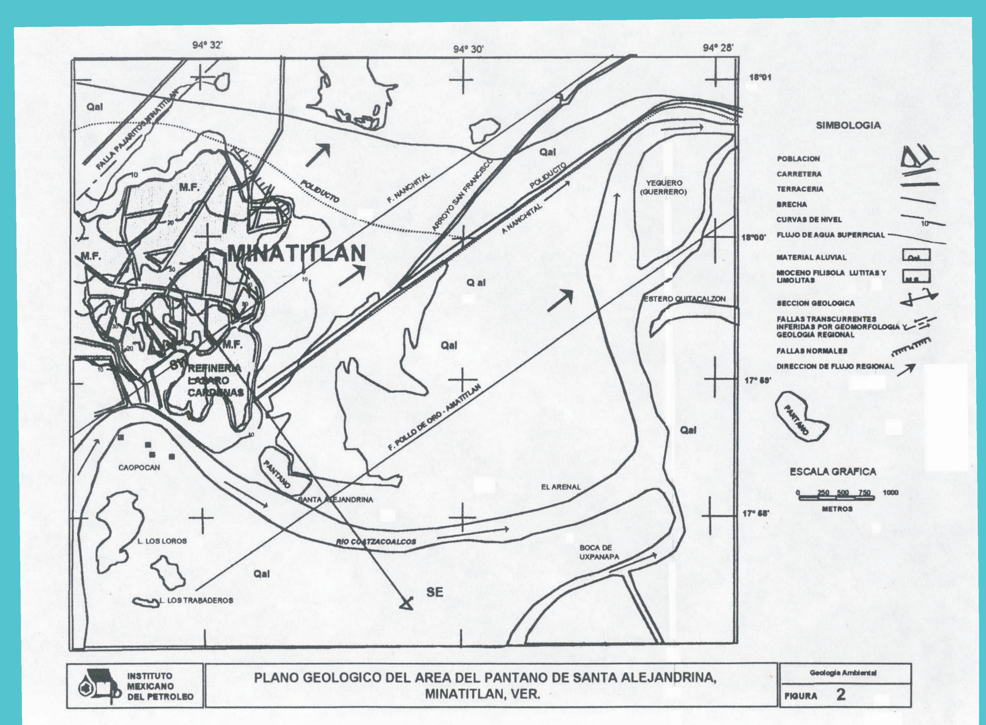

Figure 2. Geological Map

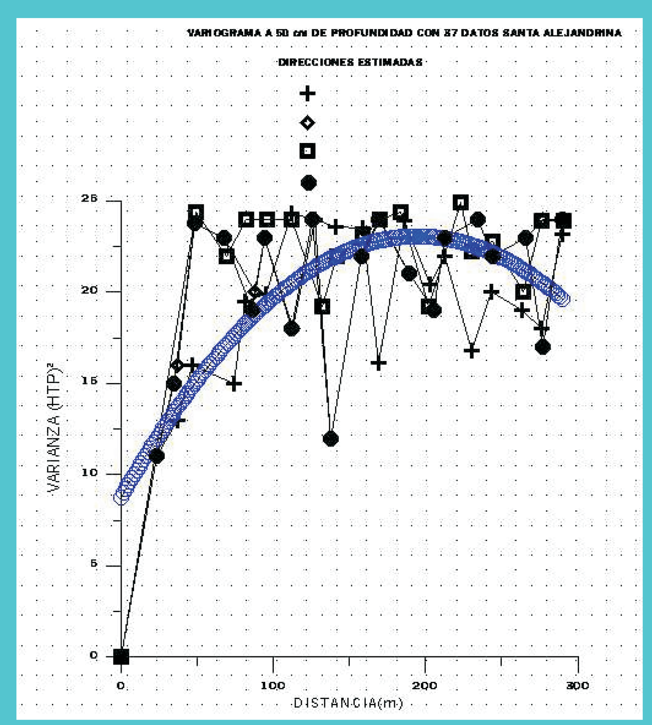

Figure 3. Superficial variogram in Santa Alejandrina

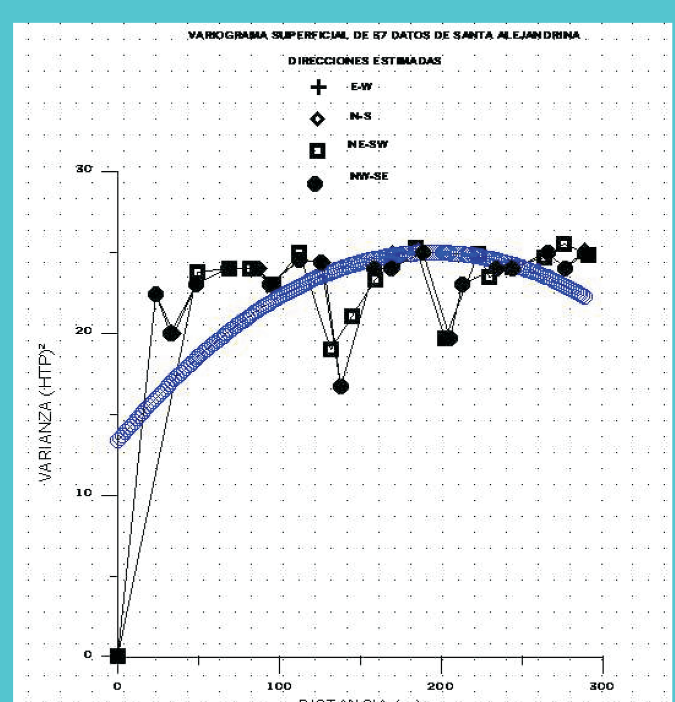

Figure 4. Distribution spatial map of TPH in surface

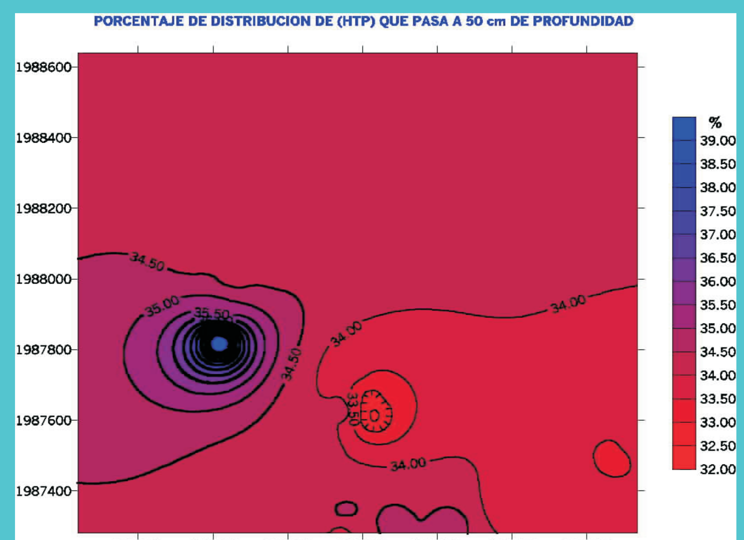

Figure 7. The cokriging variance normalized map(Average map of TPH only 34 % reaches 50 cm)

Introduction

The area of interest is located westward Minatitlán city in the geographic coordinates 17º 58' 47" north latitude and 94º 32' 27" west longitude and 60 meters above mean sea level (UNAM, 1990) its western limit is the *General Lázaro Cárdenas* refinery and southern is Coatzacoalcos river (Figure 1). The area is characterized by a great spread of swamps covered partially by grass, terrane shows smooth ondulations formed possibly durin Pleistocene (2.5 My), this was produced by aluvial sedimentation of high volumes of sedimentation transported to the Gulf of Mexico by the regional hydrological system. The area is locates into the Gulf of Mexico coastal plains fisiographic province. This zone corresponds to the geologic province of basins, into the low embayment of Coatzacoalcos river (coast plains of southern gulf). The isostatic compensation index is lee than cero witch means a low degree of isostatic compensation.
This is evidence of a high tectonic activity and consequently vertical motions of continental blocks with horizontal component that drive the kinematics of sedimentation in diagenetic processes with high energy focused mainly to the Gulf of Mexico (Flores et al., 2000; 2001).
Weather in the zone is tropical, in the coast plains of tha Gulf of Mexico, the annual mean temperature ranges between 24º and 26º degrees centigrade. Abundant rain come between July and September, getting slow by winter; the annual mean precipitation is 2041 mm. Soil is tipically Acrisoil, Nitrosoil, and Verticoil with subterrane accumulation of muds.

Geology

The fisiographic scenario of the studied area is located into the coast plains of the Gulf of Mexico with an area of 100 km^2 and with refinery placed in the center (Figure 2).
Several litological units are presented as a stratigraphic sequence:

Filisola formation (FM). Uppermost part is mainly brown colored mudstone, intemperizing in red. Deeper is possible to find middle size grain sand stone, hard and soft, with mica. Its age is Miocene (26 My) and outcrop widely in the area, it is possible to recognize smooth hills as high as 40 meters above mean sea level. This formation is the bottom bed in the refinery area and act as acuitardo with the water.

Alluvium (Qal). It is possible to find in low areas and is mainly formed by alluvial and eolic material, limes and sands lies discordantly over FM.

Sedimentary behavoir in this region are:

Palustrial (Qpa). Not consolidated sediments mainly formes by mud and lime, porportionally low it is possible to find sands bedded as thin beds. They are deposited in a reductor behavoir with with low wather circulation and anaerobic organic material. Based in sedimentary composition this unit has low permeability and cinsequently covered most of the time by water.

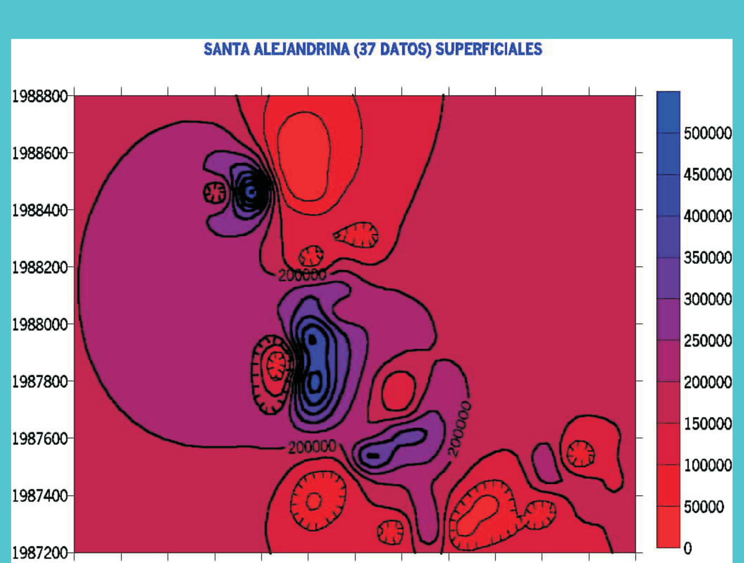

Figure 5. Variogram at deep-set 50 cm in Santa Alejandrina

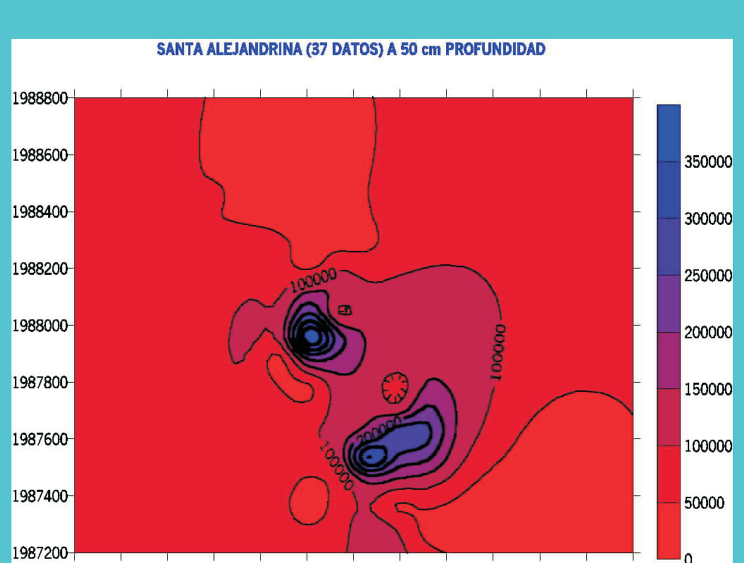

Figure 6. Distribution spatial map of TPH in surface

At this stage it is possible to compare samples acquired at two different depths (surface and 50 cm) using cokriging geostatistical method. This tool has been widely used with positive results (Carr et al., 1985; Herterbrand and Cressie, 1994; Flores et al., 1997; Flores et al., 2001). The relationship between two depths in Hydrocarbons infiltration result of 1 to 34.24 1.11. This means that of 100% of spilled hydrocarbons in surface, only 34% reaches the 50 cm of depth of muddy soil in the sampled areas acting like a molecular filter (Figure 7).