Universal Journal of Petroleum Sciences **1 (2013), 1-14**
www.papersciences.com

General Form of Non-linear Real-Time Expert Seismology for Oil and Gas Reserves Exploration

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Abstract

The new theory of "***Non-linear Real-Time Expert Seismology***" is investigated, by using a non-linear 3-D elastic waves real - time expert system for the exploration of the on-shore and off-shore petroleum and gas reserves all over the world. This new technology is working under Real Time Logic for searching the on-shore and off-shore oil reserves developed on the continental crust and in deeper water ranging from 300 to 2500 m, or even much more. So this real - time expert system, will be the best device for the exploration of the continental margin areas (shelf, slope and rise) and the very deep waters, as well. There is no limit on the depth of the seas and oceans where this method can be used. Also, this real-time expert system will be suitable for the exploration of on-shore petroleum and gas, too. The main objectives for exploration of on-shore and off-shore oil reserves are to locate, characterize and evaluate the size of these fuel resources all over the world. Hence, there is a research and development responsibility for the acquisition and analysis of all the geophysical, geological and reservoir engineering data for the land and the seas in the whole world, in order to be explored their petroleum and gas reserves. Through the proposed modern technology of *"Non-linear Real-time Expert Seismology"*, it will be possible the exploration of a significant part of on-shore and off-shore oil reserves very fast and by a low cost.

Key Word and Phrases
Non-linear Real-time Expert Seismology, Real - Time Logic, Non-linear Real - Time Expert System, Generic Technology, On-shore Oil and Gas Reserves, Off-shore Oil and Gas Reserves.

1. Introduction

There is a general feeling by international oil companies and scientific petroleum institutes all over the world, that the unexplored on-shore and off-shore petroleum & gas resources should be too many, many times more than the terrestrial reserves of Middle - East. Furthermore, many recent test drillings in the Continental Shelf of Europe and rest world have shown the existence of significant oil and gas reserves.

Three are the main areas for the research and development aspects of on-shore and off-shore oil reserves:

(a) The determination of the necessary standards and data for the safety to off-shore and on-shore operations.
(b) The acquisition and analysis for the geophysical, geological and reservoir engineering data to enable an appreciation to be made of the oil and gas reserves.
(c) To assist the development of the off-shore and on-shore supplies industry, and to enable it to play a full part in the development of the off-shore and on-shore oil and gas resources in worldwide markets in the future.

Beyond the above, the usual probability considerations indicate that off-shore oil reserves will be found in areas of thick sedimentary sequences developed on the continental crust. So, if this is true, then the continental margin areas (shelf, slope and rise) should offer good prospects of containing oil and gas resources. However, up to present the potential of sediments both on and off the shelf remains unquantified. Furthermore, there are deep waters prospects in the seas and oceans all over the world, but because of the paucity of the available information it is not possible at present to quantify the amounts that may be recoverable from them. On the contrary, there is a considerable feeling that very deep waters (2000 to 3000 m, or even more) offer good possibilities to find hydrocarbon fuels.

Since 1920 the basic and prevalent theory on oil and gas reserves exploration, has been *"Reflection Seismology".* According to this method the basic idea is to collect reflections of elastic (seismic) waves and then through various mathematical operations, by using Snell's law and Zoeppritz equations to convert them to maps of the earth's structure. [1] - [9]. Hence, the method of "Reflection Seismology" for almost a century, has been used with several improvements for oil and gas resources exploration.

On the other hand, by the present research for the on-shore and off-shore oil and gas reserves exploration the new theory of *"Non-linear Real-Time Expert Seismology"* is proposed, as was recently proposed by E.G.Ladopoulos [10]-[12]. Furthermore, this is an extension of the non-linear methods for fluid mechanics as proposed by E.G.Ladopoulos et al. [13]-[24]. So, *"Real-Time Expert Seismology"* is a very "*innovative*" and "*groundbreaking*" method on oil and gas reserves exploration. According to the new technology a non-linear 3-D elastic waves real - time expert system is proposed and investigated for the exploration of the oil and gas resources worldwide, including the off-shore oil reserves, of the seas all over the world. This new Technology will work under Real Time Logic [25]-[29] for searching off-shore fuel reserves developed on the continental crust and on deeper water ranging from 300 to 2500 m, or even much more. Thus, the proposed real - time expert system will be the best device for the exploration of the continental margin areas (shelf, slope and rise) and the very deep waters, as well. Beyond the above, this expert system will be suitable for the exploration of on-shore oil and gas reserves, too.

There are many basic benefits of the new theory of "*Real-Time Expert Seismology*" in comparison to the existing theory of *"Reflection Seismology".* Some of them are as following:

A) The new technology *"Real-Time Expert Seismology"* is based on the special form of the geological anticlines of the bottom of the sea, in order to decide which areas of the bottom have the most possibilities to include oil and gas reserves.

On the contrary, the existing theory is only based to the best chance and do not include any theoretical and sophisticated model. At present oil companies by using the existing method of "Reflection Seismology" have to do a lot of expensive test drillings in big areas of seas, if they want to have a chance to find petroleum and gas reserves.

B) The new technology of elastic (sound) waves is based on the difference of the speed of the sound waves which are travelling through solid, liquid, or gas. In a solid the elastic waves are moving faster than in a liquid and the air, and in a liquid faster than in the air.

On the other hand, existing theory is based on the application of Snell's law and Zoeppritz equations, which are not giving satisfactory results, as these which we are expecting by the new method.

C) The new technology *"Real-Time Expert Seismology"* is based on a Real-time Expert System working under Real Time Logic, that gives results in real time, which means every second.

Existing theory do not include real time logic.

From the above described three points it can be well understood the evidence of the applicability of the new method of "*Real-Time Expert Seismology*". Also its novelty, as it is based mostly on a theoretical and very sophisticated Real-time Expert model and not to practical tools like the existing method.

2. General Form of Real-time Expert Seismology

Generally, off-shore operations consist of 90% of all data collected worldwide for petroleum and gas reserves exploration. The depth of the drillings are usually up to 6000 m, but sometimes in order to find big oil and gas reserves they may extend to 10,000 m or even to 12,000 m. Furthermore, big oil companies and research organisations by studying geological surveys all over the world indicate that oil reserves do not necessarily end at the edge of the continental shelf. Thus, there is serious expectation that main resources will be found in areas of thick sedimentary sequences developed on the continental crust. So, there are good possibilities for finding off-shore oil and gas reserves in deep waters, too, ranging up to 2500 m to 3000 m, or even more.

Beyond the above, the behavior of a reservoir, depends not only on the properties of the liquid and gas, but also on several factors that may be termed as the "*properties of the environment*". Among these factors are items like several pressure effects, the reaction of rock when subjected to high stress, pressure and temperature gradients at the shallower levels in the Earth's crust. Also, influences of the compressibility as pressure are reduced by fluid withdrawals.

On the other hand, according to the basic theories of geology and fluid mechanics, four are the basic conditions that must be satisfied so that a geological formation, or a part thereof, should form a suitable reservoir, for example for the accumulation of oil or gas. These are porosity, permeability, seal and closure. Porosity is defined as the pore space in the rock - space in which the oil may collect. Permeability is the attribute of the rock that permits the passage of fluid through it. Generally, it is a measure of the degree interconnectedness, of the pore space, but some reservoir (e.g. in the massive limestone deposits, or in igneous intrusions) depends for fluid flow on a network of fractures within the rock.

Furthermore, the seal is the "cap" of the reservoir and prevents the oil from leaking away. Also, closure is a measure of the vertical extent of the sealed trap or, in the case of resources accumulation bounded below by a moving body of water, of the "height" of the sealed trap where that height is measured along a line perpendicular to the oil - water contact.

On the other hand, there is a general belief by international oil companies that almost all resources occur in porous standstones or limestones and in sedimentary basins, and that seal or cap rock is often a clay or shale, or massive unfractured limestone having little or no permeability. Furthermore, three general categories of resources can be mentioned for off-shore reserves: structural traps, stratigraphic traps and combination traps.

Elastic waves are sound waves, usually three - dimensional which may be transmitted through matter in any phase - solid, liquid, or gas. Generally, any body vibrating in air gives rise to such waves, as it alternately compresses and rarefies the air adjacent to its surfaces. Also, a body vibrating in a liquid, or in contact with a solid, likewise generates similar longitudinal waves. Of course the frequency of the waves is the same as the frequency of the vibrating body that produces them. So, there are two types of elastic waves produced: a) P-waves, which are primary or "compressional" waves, and b) S-waves, or shear waves.

Wavelength of the wave is the distance between two successive maxima (or between any two successive points in the same phase) and is denoted by l. Since the waveform, travelling with constant velocity u, advances a distance of one wavelength in a time interval of one period, then it follows that the velocity of sound waves u is given by the following relation:

$$u = l\, v \tag{2.1}$$

where v denotes the frequency.

As it is obvious, the velocity u differs when the sound waves are travelling through solid, liquid, or gas. In a solid the elastic waves are moving faster than in a liquid and the air, and in a liquid faster than in the air. Hence, if somebody is searching for example for off-shore oil resources over the sea, by transmitting sound waves, then there will be a difference in the velocity of the waves in the sea, the solid bottom and in a potential reservoir.

For better explanation of the new technology, consider the example of Figure 1. In this example consider that in the bottom of the sea there is a potential petroleum reservoir. In such a case, the speed of the elastic waves in the air (u_{air}), will be different from the speed in the water (u_{water}), and different from the speed in the solid bottom (u_{solid}) and different from the speed in the potential reservoir (u_{oil}), while the frequency of the elastic waves remaining the same when transmitted through every different matter.

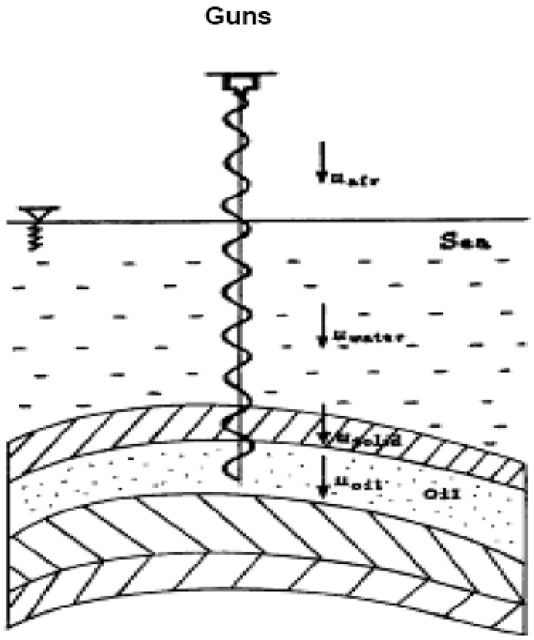

Fig. 1 Elastic Waves Method for the Exploration of Oil Reserves.

Thus, by the present investigation a real - time non-linear 3-D plane - polarized elastic waves expert system is proposed in order to explore the on-shore and off-shore oil resources, according to the new theory of *"Real-Time Expert Seismology"*, in contrast to the old theory of *"Reflection Seismology"*. This new Sound Waves Technology will work under Real Time Logic for searching off-shore oil reserves developed on the continental crust and on deeper waters ranging from 300 m to 2500 m, or even much deeper (Figure 2). On the contrary, there are many deeper water prospects around the seas all over the world, but because of the paucity of the available information it is not possible at present to quantify the amounts that may be recoverable from them.

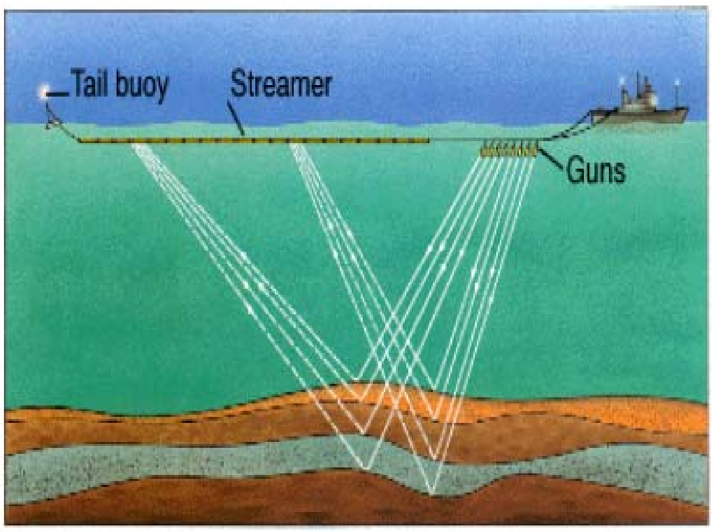

Fig. 2 Real-time Expert Seismology.

Hence, the proposed real - time elastic waves expert system will be the best device for the exploration of the continental margin areas (shelf, slope and rise) and the very deep waters ranging of more than 2500 ÷3000 m, too. So, through the very modern technology of "*Real-Time Expert Seismology*", the exploration of a significant part of on-shore and off-shore petroleum and gas reserves will be effected fastly and by a low cost.

According to our proposed modern technology of *"Real-Time Expert Seismology"* the average velocity of the sound waves is calculated by providing important information about the composition of the solids through of which passed the sound waves. For example the velocity of the sound waves through the air is 331 m/sec, through liquid 1500 m/sec and through sedimentary rock 2000 to 5000 m/sec. Furthermore, according to the law of Reflection the angle of reflection equals the angle of incidence (Figure 3). Then according to the new method the arrival times of the seismic waves are analyzed. After the sensor measures the precise arrival time of the wave, then the velocity of the wave can be calculated by using the following method.

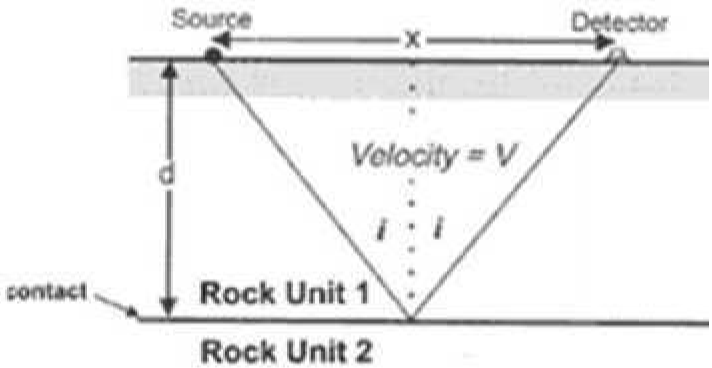

Fig. 3 Law of Reflection.

The travel time T of the seismic waves is given by the relation:

$$T = \frac{2\left(d^2 + x^2/4\right)^{1/2}}{v} \tag{2.2}$$

where d denotes the depth, x the distance between source of wave and the geophone or hydrophone detector and v is the average speed.

Beyond the above, from (2.2) follows equation (2.3):

$$T^2 = \frac{4d^2 + x^2}{v^2} \tag{2.3}$$

Also, the normal incident time T_o is given by the formula:

$$T_o = \frac{2d}{v} \tag{2.4}$$

From eqs (2.3) and (2.4) follows:

$$T^2 - T_o^2 = \frac{x^2}{v^2} \tag{2.5}$$

and finally from (2.5) the mean velocity is equal to:

$$v = \frac{x}{\sqrt{T^2 - T_o^2}} \tag{2.6}$$

Hence, a real time expert system is proposed and the apparatus permitted excitation of any combination of elements and reception of any other, visual analysis of the responses, and transfer of the signals to the PC for post processing. The sequencing of transducer excitation, digitiser configuration and subsequent data analysis was performed by a rule based Real-Time Expert System. Then from the information gathered, the Expert System applies knowledge via a series of software coded rules and provides any one of the following conditions:
speed in the water (u_{water}), speed in the solid bottom (u_{solid}) and speed in the potential reservoir (u_{oil}),

3. Generalized Type of Refraction for Real-time Expert Seismology

In general, the seismic refraction method is similar to the reflection method in that the same instruments and shock wave sources are used. However, as the name implies, the objective of the refraction method is to measure refraction of shock waves as they pass across formation or structural boundaries (Figure 4). Refraction is governed by Snell's Law, which relates velocity to the angle of incidence and to the angle of refraction.

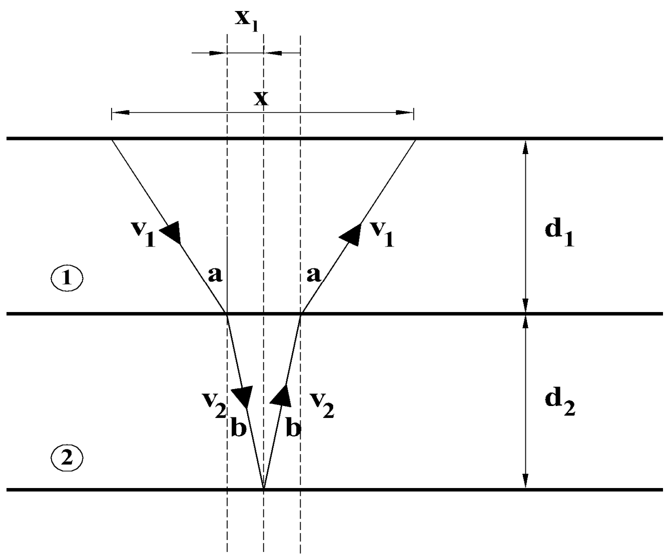

Fig. 4 Law of Refraction..

The travel time T_1 of the seismic waves in the first solid is given as following:

$$T_1 = \frac{2\left({d_1}^2 + (\frac{x}{2} - x_{l_1} - x_{l_2})^2 \right)^{1/2}}{v_1} \tag{3.1}$$

in which d_1 denotes the depth, x the distance between source of wave and the geophone or hydrophone detector, x_{l_1} the distance between the ends of the first two waves (Figure 4), x_{l_2} the distance between the ends of the next two waves (Figure 4), and v_1 is the speed of the wave in the first solid.

From (3.1) follows equation (3.2):

$$T_1^2 = \frac{4\left(d_1^2 + (\frac{x}{2} - x_{l_1} - x_{l_2})^2\right)}{v_1^2} \tag{3.2}$$

Furthermore, the normal incident time T_{1o} is given by the relation:

$$T_{1_o} = \frac{2d_1}{v_1} \tag{3.3}$$

From eqs (3.2) and (3.3) follows:

$$T_1^2 = T_{1_o}^2 + \left[\frac{2(\frac{x}{2} - x_{l_1} - x_{l_2})}{v_1}\right]^2 \tag{3.4}$$

Also, by replacing (3.3) in (3.4) we obtain:

$$d_1 = \frac{(\frac{x}{2} - x_{l_1} - x_{l_2})T_{1o}}{(T_1^2 - T_{1_o}^2)^{1/2}} \tag{3.5}$$

By the same way the travel time T_2 of the seismic waves in the second solid is given by the following formula:

$$T_2 = \frac{2\left(d_2^2 + x_{l_1}^2\right)^{1/2}}{v_2} \tag{3.6}$$

where d_2 denotes the depth, x_{l_1} the distance between the ends of the two waves (Figure 4) and v_2 is the speed of the wave in the second solid.

Then from (3.6) follows equation (3.7):

$$T_2^2 = \frac{4(d_2^2 + x_{l_1}^2)}{v_2^2} \tag{3.7}$$

Also, the normal incident time T_{2o} is given by the formula:

$$T_{2_o} = T_o - T_{1o} - T_{3o} = \frac{2d_2}{v_2} \tag{3.8}$$

From eqs (3.7) and (3.8) follows:

$$T_2^{\ 2} = T_{2_o}^{\ 2} + \left(\frac{2x_{l_1}}{v_2} \right)^2 \tag{3.9}$$

Beyond the above, by replacing (3.8) in (3.9) one obtains:

$$d_2 = \frac{x_{l_1}(T_0 - T_{1o})}{\left[(T - T_1)^2 - (T_o - T_{1o})^2 \right]^{1/2}} \tag{3.10}$$

Because of Snell's law it is valid:

$$\frac{v_2}{v_1} = \frac{\sin b}{\sin a} \tag{3.11}$$

where *a* denotes the angle of incident and *b* the angle of refraction.

Finally, if T is the total travel time of the waves in the three solids ($T = T_1 + T_2 + T_3$) and by using (3.2), (3.7) and (3.11) follows:

$$\frac{T_1}{T_2} = \frac{x_{l_1} \left(d_1^{\ 2} + (\frac{x}{2} - x_{l_1} - x_{l_2})^2 \right)}{(\frac{x}{2} - x_{l_1} - x_{l_2})(d_2^{\ 2} + x_{l_1}^{\ 2})} \tag{3.12}$$

By following the same method the travel time T_3 of the seismic waves in the third solid is given by the relation:

$$T_3 = \frac{2\left(d_3^{\ 2} + x_{l_2}^{\ 2} \right)^{1/2}}{v_3} \tag{3.13}$$

where d_3 denotes the depth, x_{l_2} the distance between the ends of the next two waves (Figure 4) and v_3 is the speed of the wave in the third solid.

Then from (3.13) follows equation (3.14):

$$T_3^{\ 2} = \frac{4(d_2^{\ 2} + x_{l_2}^{\ 2})}{v_3^{\ 2}} \tag{3.14}$$

Also, the normal incident time T_{3o} is given by the formula:

$$T_{3_o} = T_o - T_{1o} - T_{2o} = \frac{2d_3}{v_3} \tag{3.15}$$

From eqs (3.14) and (3.15) follows:

$$T_3^{\;2} = T_{3_o}^{\;2} + \left(\frac{2x_{l_2}}{v_3} \right)^2 \tag{3.16}$$

Furthermore, by replacing (3.15) in (3.16) we obtain:

$$d_3 = \frac{x_{l_2}(T_0 - T_{1o} - T_{2o})}{\left[(T - T_1 - T_2)^2 - (T_o - T_{1o} - T_{2o})^2 \right]^{1/2}} \tag{3.17}$$

Because of Snell's law one has:

$$\frac{v_3}{v_2} = \frac{\sin c}{\sin b} \tag{3.18}$$

where *b* denotes the angle of incident and *c* the angle of refraction.

Finally, if T is the total travel time of the waves in the three solids ($T = T_1 + T_2 + T_3$) and by using (3.9), (3.14) and (3.18) follows:

$$\frac{T_2}{T_3} = \frac{x_{l_2}}{x_{l_1}} \left(\frac{d_2^{\;2} + x_{l_1}^{\;2}}{d_3^{\;2} + x_{l_2}^{\;2}} \right)^{1/2} \tag{3.19}$$

From equations (3.12) and (3.19) can be calculated the uknown x_{l_1} and x_{l_2} .

By the same way if the elastic waves travel inside m solids, then d_m is calculated by the formula:

$$d_m = \frac{x_{l_{m-1}}(T_0 - T_{1o} - T_{2o} - .... - T_{(m-1)o})}{\left[(T - T_1 - T_2 - .... - T_{(m-1)})^2 - (T_o - T_{1o} - T_{2o} - .... - T_{(m-1)o})^2 \right]^{1/2}} \tag{3.20}$$

which reduces to:

$$d_m = \frac{x_{l_{m-1}}(T_0 - \sum_{i=1}^{m-1} T_{io})}{\left[(T - \sum_{i=1}^{m-1} T_i)^2 - (T_o - \sum_{i=1}^{m-1} T_{io})^2 \right]^{1/2}} \tag{3.21}$$

Finally, between the m and the (m-1) solid the following relation is valid:

$$\frac{T_{m-1}}{T_m} = \frac{x_{l_{m-1}}}{x_{l_{m-2}}} \left(\frac{d_{m-1}^{\;2} + x_{l_{m-2}}^{\;2}}{d_m^{\;2} + x_{l_{m-1}}^{\;2}} \right)^{1/2} \tag{3.22}$$

4. Real-time Logic for Oil and Gas Reserves Exploration

Real-time logic (RTL) is a reasoning system for real-time properties of computer based systems. Thus, the computational model of Real-time logic consists of events, actions, causality relations, and timing constraint. Such a model is expressed in a first order logic describing the system properties as well as the systems dependency on external events. The Real - Time Logic system introduces time to the first logic formulas with an event occurrence function, which assign time values to event occurrences. Such a kind of real - time logic systems were studied by F. Jahanian and A. Mok [25] ,[26].

Beyond the above, real-time computing in common practice is characterized by two major criteria: deterministic and fast response to external stimulation, and both human and sensor and actor based interaction with the external world. So, it is clear that Real-time is an external requirement for a peace of software; it is not a programming technology. There are some special software tools for the implementation of real - time systems. Such a type of real - time programming languages were investigated by several scientists like R.Emnis et all [27] , W. Fritz , V. H. Haase and R. Kalcher [28] and V. H. Haase [29] .

Generally, Real-Time Logic uses the following three types of constraints:

a. Event constants are divided into three cases. Start/stop events describe the initiation/termination of an action or subaction. Transition events are those which make a change in state attributes. According to this theory a transition event changes an assertion about the state of the real-time system or its environment. The third class, which are the external events, includes those that can be impact the system behavior, but cannot be caused by the system.
b. Action constants may be primitive or composite. In a composite constant, precedence is imposed by the event-action model using sequential or parallel relations between actions.
c. Integers assigned by the accurance function provide time values, and also denote the number of an event occurance in a sequence.

Furthermore, the Real - Time Logic System introduces time to the first order logic formulas with an event occurance function denoted by e. The mechanism to achieve a timing property of a system is the deduction resolution.

Finally, consider the following example: Upon pressing button ≠ 70, action TEST is extended within 700 time units. Dusting each execution of this action, the information is sampled and subsequently transmitted to the display panel. Also, the computation time of action TEST is 200 time units.

This example can be further translated into the following two formulas:

$$\forall\ x : e(\ \Omega\ \text{button}\ 70,\ x) \leq e(\uparrow\ \text{TEST}\ ,\ x) \ \wedge$$
$$e(\downarrow\ \text{TEST}\ ,\ x) \leq e(\ \Omega\ \text{button}\ 70,\ x) + 700$$
$$\forall\ y : e(\uparrow\ \text{TEST}\ ,\ y) + 200 \leq e(\downarrow\ \text{TEST}\ ,\ y)$$

5. Oil and Gas Reservoir Exploration by Elastic Seismic Waves

Suppose that a seismic wave of any sort travels from left to right in a medium. Then the equation of the travelling wave is valid as:

$$y(\zeta,t) = A\cos(\omega t - k\zeta) \tag{5.1}$$

in which k denotes the wave number given by the relation:

$$k = 2\pi / \lambda \tag{5.2}$$

and λ is the wavelength, t the time, A the amplitude of the motion and $\omega=2\pi v$, v the frequency.
A sinusoidal transverse wave travelling toward the right , at intervals of period 1/8 can be seen in Figure 5.

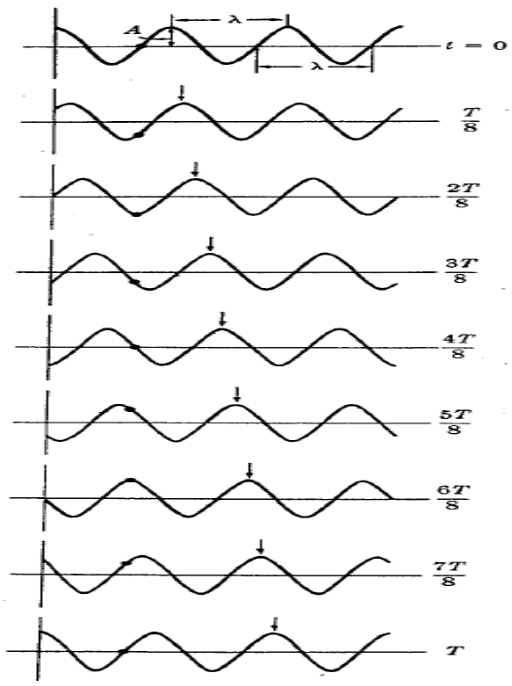

Fig. 5 A sinusoidal transverse wave travelling toward the right, at intervals 1/8 of a period.

Furthermore, it is important to distinguish between the motion of the waveform, which moves with constant velocity u along the string, and the motion of a particle of the string, which is simple harmonic and transverse to the string. In order to be understandable the mechanics of seismic waves, consider Figure 6.

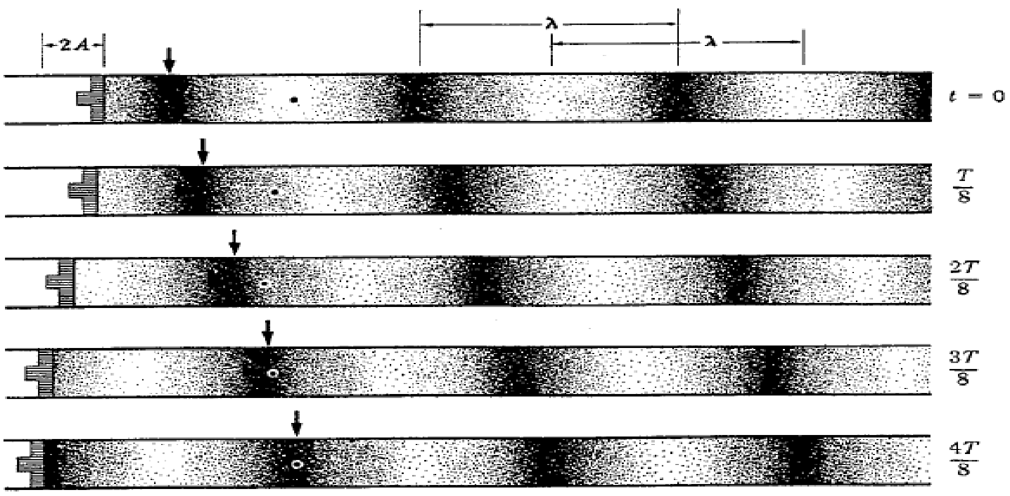

Fig. 6 Sinusoidal longitudinal waves, travelling toward the right, at intervals 1/8 of a period.

Also, by differentiating the wave equation (5.1) one has:

$$\partial y / \partial \zeta = kA \sin(\omega t - k\zeta) \tag{5.3}$$

$$\partial y / \partial t = -\omega A \sin(\omega t - k\zeta) \tag{5.4}$$

By combining eqs {5.3) and {5.4) and as the velocity is equal to:

$$u = \omega / k \tag{5.5}$$

then finally one obtains:

$$\frac{\partial y}{\partial \zeta} = -\frac{1}{u}\frac{\partial y}{\partial t} \tag{5.6}$$

which by a second differentiation reduces to:

$$\frac{\partial^2 y}{\partial t^2} = u^2 \frac{\partial^2 y}{\partial \zeta^2} \tag{5.7}$$

Generally, in a transverse wave motion the individual particles vibrate in a direction perpendicular to the direction of propagation of the wave. But there are many such directions - indeed, there are infinitely many. So, in Figure 7 can be seen three transverse waves, all travelling in the same direction, but lying in different planes from one another: A in a vertical plane, B in a horizontal plane, C in a plane inclined at an angle of 45° to each of these. In each of the above cases the motion of each individual particle is restricted to a single straight line, and the entire wave to a single plane. Each of these waves is said to be plane - polarized. Also, because of their non - linear behavior, are called non - linear plane - polarized. But more complex seismic waves could be generated by moving one end in any periodic manner, not restricted to a single straight line. In such cases, each particle has two - dimensional motion (it moves in a plane) and the entire wave is three - dimensional. Even then the wave is not necessarily un-polarized, while if the vibrations are ordered in any case, the wave is to some degree polarized.

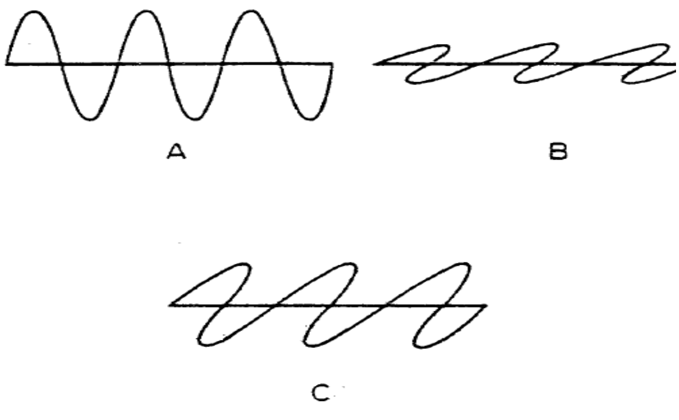

Fig. 7 Transverse waves, travelling in the same direction, but lying in different planes from one another.

6. Conclusions

By the present research the new theory of *"Real-Time Expert Seismology"* has been introduced and investigated for the exploration of on-shore and off-shore oil and gas reserves. As the test marine drillings are very expensive with costs of many billions of EURO or USD and many times unsuccessfully, meaning a big loss of funds, then the highly innovative and groundbreaking method *"Real-Time Expert Seismology"* has been proposed and investigated. By the new and sophisticated technology for energy applications it will be established a strong scientific and technical base for the Science & Technology in the worldwide in the emerging areas of oil reserves exploration in the energy field. Thus, through the new technology of *"Real-Time Expert Seismology"*, will be effected the exploration of a significant part of on-shore and off-shore oil and gas reserves all over the world very fast and by a low cost.

The oil and gas market are markets of many billions every year worldwide. Thus, this contribution requires an international approach, rather than a local approach, as it is referred to a market all over the world with value of many billions of EURO or USD. So it is expected in order the big oil companies to keep and to improve their leading role in the worldwide Science & Technology, to get involved in the new and groundbreaking technology in the area of Energy, which is proposed by the present investigation.

Furthermore, the potential areas and markets of application of the proposed technology will be the oil market all over the world. The method's results will be applicable to all oil companies and scientific organizations working on oil exploration all over the world. It is expected through our proposed new and modern technology the cost for oil exploration to be reduced too much, as there will be no need for so many test drillings, as today. The test drillings cost many billions, and the new technology will reduce them in the possible minimum.

Finally, as the proposed new technology *"Real-Time Expert Seismology"*, is based on a non-linear 3-D elastic waves real - time expert system, working under real logic, then is expected to give the best results. Thus, our proposed high technology method is based on a very sophisticated model by checking the geological anticlines of the bottom of the sea, in order to decide which areas of the bottom have the most possibilities to include petroleum. It is therefore not necessary to make test drillings in the half ocean in order to find petroleum, like the existing methods.

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