ΣΕΙΣΜΟΛΟΓΙΑ.— **On the Average and Maximum Recurrence Interval of the last 4000 years Caldera - Forming Global Explosive Eruptions,** by Academician *A. G. Galanopoulos**.

A tabulation of the age and volume of pyroclastic material of historic and prehistoric global eruptions that formed calderas was recently given by R. W. Decker (1990). In addition to this, a volcanic explosivity index (VEI) is assigned to the listed eruptions, similar in concept to the Richter earthquake local magnitude M_L; so, each number in the VEI scale represents a 10-fold increase in the volume of pyroclastic material ejected during the related eruptions (s. Table 1).

TABLE 1.
VEI scale (Newhall and Self, 1982)

Volcanic Explosivity Index (VEI)	Pyroclastic Material in km³
5	$\geqslant$ 1
6	$\geqslant$ 10
7	$\geqslant$ 100
8	$\geqslant$ 1000

As the age of the last 4000 years calderas, as well as their number, are more or less better known than of those of the more remote past, out of the 125 listed large Quaternary calderas, we quote hier only 21 occurrences; this is made, in spite of missing VEI 8 eruptions, due to their longer average world wide recurrence interval, as the latest known eruption of this scale, occurred in Lake Toba in Sumatra, 75000 years ago, which expelled an estimated 2800 km³ of magma, nearly 100 times the amount erupted at Thera some 3600 years ago (Decker, 1990).

The logarithmic relation of the VEI magnitude, M_V, to the ejected pyroclastic material of explosive eruptions, i.e. the similarity of M_L to the M_V, allows

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* Α. Γ. ΓΑΛΑΝΟΠΟΥΛΟΣ, **Ἐπὶ τοῦ μέσου καὶ μεγίστου χρόνου ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων ποὺ σχημάτισαν μεγάλες καλδέρες στὴν ἐπιφάνεια τῆς Γῆς κατὰ τὰ τελευταῖα 4000 χρόνια.**

one to think of a possible application of the very known earthquake frequency-magnitude relation of Gutenberg and Richter (1944), as well as the earthquake frequency-actual repeat time relation recently proposed by A. Galanopoulos (1988), to the frequency of large calderas occurred during the last 4000 years.

TABLE 2.

Large Calderas Occurred During the Last 4000 Years, Quoted from Table I of R. W. Decker, 1990

No	Regions and Calderas	Age in Years before 1990	Volcanic Explosivity Index (VEI)	Interevent Time in Years
1	Long Island, MELAN.	4000	6	—
2	Veniamino, USA	3700	7	300
3	Rabaul, MELAN.	3500	7	200
4	Aniakchak, USA	3400	7	100
5	Thera, MEDITER.	3380	6	20
6	Witori, MELAN.	2600	6	780
7	Iwo-Jima, JAPAN	2600	7	0
8	Okmok, USA	c. 2400	7	200
9	Masaya, USA	c. 2220	6	180
10	Ksudach, KAMCH.	c. 2100	6	120
11	Taupo, N. ZEAL.	c. 1800	6	300
12	Hopango, MID. AMER.	1730	6	70
13	Krakatau, INDON.	1574	6	156
14	Rabaul, MELAN.	1400	6	174
15	Dakataua, MELAN.	c. 1150	7	250
16	Tien-Chi, CHINA	c. 850	6	300
17	Oshima, JAPAN	c. 550	6	300
18	Long Island, MELAN.	300	6	250
19	Tambora, INDON.	175	7	125
20	Krakatau, INDON.	107	6	68
21	Katmai, USA	78	6	29

However, in the present case the application of this methodology meets an objection: the existence in this span of time of only two classes of M_V, and two

groups of actual repeat times, t, expressed as unit time the average interoccurrence time, m = 190 years (= 4000 : 21). As a matter of fact there are 7 occurrences in the 7 M_V class and 14 in the 6M_V. Also, there are 11 repeat times (55%) in the first group ($\leqslant$ 190 years) and 8 (40%) in the second ($\leqslant$380 years); besides, there is 1 (5%) outlying repeat time (780 years) that falls in the fifth group ($\leqslant$ 950 years).

Disregarding the outlying repeat time, the above data fit the Gutenberg-Richter's and Galanopoulos' earthquake recurrence models as follows, respectively:

$$\text{Log}\,(N_c) = 4.184 - 0.477M_v \qquad (1)$$

$$\text{Log}\,(N_c) = 1.653 - 0.375t \qquad (2)$$

where N_c is the cumulative frequency of the explosive eruptions considered, i.e. the sum of eruptions in each M_v class or t group plus all those that are larger, M_v, the VEI magnitude and t the rank of the group of actual repeat times expressed as unit time the average interoccurrence time, m = 190 years. It is needless to say that the equations (1) and (2) are valid merely for the range 6 to 7 and 1 to 2, respectively.

Considering that the number of at least the large prehistoric eruptions is rather roughly known and the VEI magnitude assigned to them was based on several assumptions (Decker, 1990), the discrepancy in the factors, by which the frequency of the eruptions decrease in each magnitude increase, derived from the number and magnitude of the recorded explosive eruptions during the past 200 and 10 years and of those occurred during the last 4000 years is rather small (5 and 3, respectively). The drawback of the 2 points range used for the present estimation is compensated to some extent by the fact that each point consists of much more events than the single event of VEI 7 point used for the past 200 years (Decker, 1990).

However, the 200 years time derived for an average global recurrence of eruptions as large or larger than the Minoan eruption compares well to the 190 years mean repeat time computed directly from the time span of 4000 years and the number of VEI 6 and larger eruptions, 21, occurred during the period considered. It is worth noting that the maximum recurrence time, t_{max} (=190 $\times$ $\times$ 1.653 : 0.375), derived from the second equation, 838 years, falls within the range of the fifth group of repeat times, as that of 780 years does. This may

indicate that the Galanopoulos' recurrence model allows the computation of the maximum recurrence interval of explosive eruptions as well as that of earthquakes. Regarding the 330 years recurrence time of large eruptions derived from the 10,000 years period (Decker, 1990), this falls within the time interval of the mean, m, and the maximum repeat time, t_{max}, computed from Galanopoulos' earthquake recurrence model. However, in view of the VEI 6.9 magnitude assigned to Minoan eruption (Decker, 1990) and the validity of the equation (1) in the magnitude range VEI 6 to VEI 7, the average return period of global eruptions of this size and larger is approximately 500 years.

Lastly, assuming that the average volcanic activity per 80 square degrees area, equal to that of Greece (34°N42°, 19°E29$_v$) holds for the global area, as well as that the equation (1), reduced to one year (Log $N_c = 0.582 - 0.477\ M_v$), holds for tens of thousands of years to come, and accepting the VEI 6.9 magnitude assigned to the Minoan eruption of Thera, we arrive at the conclusion that the preparation time for a future eruption in the area of Greece, of size equal to that of the Minoan eruption and larger amounts to about 400,000 years.

In an alternative assumption, that the average volcanic activity per 80 square degrees area holds indeed for a very limited area of the Globe, equivalent to about two volcanic belts round the Globe roughly 8 degrees wide, then the mean recurrence time for a future eruption of Minoan size and larger in the area of Greece is approximety in the range of 36,500 years.

Nevertheless, accepting an average global recurrence of eruptions as large or larger than the Minoan eruption the 200 years period estimated by graphical analysis of data on the frequency of the recorded eruptions of the past two hundred years plotted against magnitude (Decker, 1990) and adopting the second assumption for the roughly equivalent area of global volcanic activity (c. 5760 square degrees), the return period of eruption of Minoan size and larger in the major area of Greece (c. 80 square degrees) is about 14,400 years ($= 5760/80 \times 200$). This estimation, oddly enough, compares very well with the long period of volcanic quiescence*, which preceded the great Late Minoan

* Volcanologists tend, more often than not, to surmise the behaviour and particularly the duration of Minoan eruption from that of the 1883 eruption of Krakatau, or other younger vulcanian eruptions, disregarding the great difference in the preceded time of volcanic quiescence of Thera compared to that of about 1400 years in the case of Krakatau.

eruption of the Thera volcano for about 15,000 years (Pichler and Friedrich, 1976; Friedrich et al., 1980).

In another approach to the problem of estimation of the average return period of volcanic eruptions in the major area of Greece, we adopt the hypothesis of the origin of volcanoes offered by Hugo Benioff (1954). According to this hypothesis, the heat liberated in the depts during the aftershock sequences appears much later in the form of volcano output. A rough calculation of the energy liberated as heat in a number of aftershock sequences shows that it averages approximately half the amount of the energy liberated as seismic waves in the principal shock. This allows us to adopt the assumption that the rate of volcanic activity is proportional to that of the regional seismic energy release.

Taking now into consideration that the seismic belts over the globe coincide, more or less, with the volcanic belts, that the annual rate of seismic energy released in the major area of Greece is about 2% of the annual global energy release (Galanopoulos, 1968; 1971) and that the recurrence interval deduced from historic and prehistoric data on a world-wide basis for an explosive eruption as large or larger than the Minoan eruption of Thera is approximately 300 years (Decker, 1990), the corresponding average return period for the major area of Greece is 50 times longer, i.e. $50 \times 300 = 15{,}000$ years.

In view of the uncertainties involved in the radiocarbon dating of the volcanic eruptions, the computed time (ca. 36,500 years) compares fairly well with the mean recurrence time (ca. 33,500 years) of the 3 major volcanic events, associated with caldera collapse (Druit et al., 1989), that occurred during the last 100,000 years in the history of Santorin (3500, 18000 and about 100,000 BP).

The computed time (ca. 15000 years) approaches well enough to the mean recurrence time ((ca. 16500 years) of the 6 major explosive events (Druit et al., 1989; Keller et al., 1990) occurred during the last 100,000 years in the volcanic history of Santorin (3500, 18000 and about 37000, 54000, 79000 and 100,000 BP).

Based on these speculations we may say that the Minoan eruption was really a unique experience for the population in the area of Greece and along the shores of the eastern Mediterranean not easy to be forgotten thoroughly in the run of centuries, at least by ashore living sophisticated people, as Plato himself emphasizes in his dialogues Timaios and Kritias. As a matter of fact,

confused memories of this shocking event survived woven by poets and philosophers with later happenings in a variety of myths and legends that end with a visitation of the punishment of the gods (in Greek *Θεομηνία*). The legend of Atlantis, the tale of Deucalion's flood, the story of Hippolytus, the myth of Phaethon, the Plagues of Egypt and the Exodus of Israel, and eventually some fragments of the Revelation of St. John, the Apocalypse, are generally considered to be narative literature proper to Minoan calamity and related wide-spread phenomena (Galanopoulos, 1960 a,b,c, 1963, 1964, 1968, 1969, 1979, 1981, 1986; Mavor, 1969; Kehnscherper, 1972).

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ΠΕΡΙΛΗΨΗ

Ἐπὶ τοῦ μέσου καὶ μεγίστου χρόνου ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων ποὺ σχημάτισαν μεγάλες καλδέρες στὴν ἐπιφάνεια τῆς Γῆς κατὰ τὰ τελευταῖα 4000 χρόνια

Πρόσφατα δημοσιεύθηκε σὲ ἐργασία τοῦ R. W. Decker (1990), μὲ τίτλο «Πόσο συχνὰ συμβαίνει μιὰ Μινωϊκὴ ἔκρηξη», κατάλογος μεγάλων καλδερῶν τοῦ Τεταρτογενοῦς. Ἀπὸ τὶς ἡφαιστειακὲς ἐκρήξεις ποὺ συνέβηκαν στὰ τελευταῖα 200 χρόνια, καὶ

ἀπὸ αὐτὲς ποὺ σχημάτισαν μεγάλες καλδέρες κατὰ τὸ τελευταῖο ἑκατομμύριο χρόνια, ὁ Decker κατέληξε στὸ συμπέρασμα, μὲ τὴν γραφικὴ ἀνάλυση τῆς ἀθροιστικῆς συχνότητας τῶν ἐκρήξεων σὲ συνάρτηση πρὸς τὸ μέγεθος: (α) τῶν ἱστορικῶν, (β) τῶν προϊστορικῶν καὶ (γ) τῶν ἱστορικῶν καὶ προϊστορικῶν ἐκρήξεων, ὅτι ὁ μέσος χρόνος ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων ἐφ' ὁλοκλήρου τῆς ἐπιφανείας τῆς Γῆς μεγέθους ἴσου ἢ μεγαλύτερου τοῦ μεγέθους τῆς Μινωϊκῆς ἐκρήξεως ἐπὶ τῆς νήσου Θήρας εἶναι περίπου: 200, 330 καὶ 300 χρόνια, ἀντιστοίχως.

Στὴν παροῦσα ἐργασία γίνεται ἀπόπειρα ἀναλύσεως τῶν ἐκρήξεων τῶν τελευταίων 4000 ἐτῶν ποὺ παρουσιάζουν σχετικῶς μεγαλύτερη ἐσωτερικὴ ὁμοιογένεια στὸ πλῆθος καὶ στὰ δεδομένα τῶν πυροκλαστικῶν ὑλικῶν, ἀπὸ τὸν ὄγκο τῶν ὁποίων ὑπολογίζεται τὸ λογαριθμικὸ μέγεθος τῶν ἐκρήξεων. Ἀπὸ τὴν ἀνάλυση τῆς ἀθροιστικῆς συχνότητας τῶν ἐκρήξεων, σὲ συνάρτηση πρὸς τὸ μέγεθος καὶ τὸν πραγματικὸ χρόνο ἐπαναλήψεώς των, προέκυψαν: (α) ὁ μέσος χρόνος ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων σὲ ὁλόκληρη τὴν ἐπιφάνεια τῆς Γῆς, μεγέθους 6 καὶ ἐπάνω, 190 χρόνια περίπου, (β) ὁ μέγιστος χρόνος ἐπαναλήψεως τῶν ἐκρήξεων αὐτῶν, 800 χρόνια περίπου, καὶ (γ) ὁ μέσος χρόνος ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων μεγέθους ἴσου ἢ μεγαλύτερου τοῦ μεγέθους τῆς Μινωϊκῆς ἐκρήξεως (M = 6,9), 500 ἔτη περίπου.

Ὑπὸ τὴν ἐκδοχή: (α) ὅτι ἡ μέση ἡφαιστειακὴ δραστηριότητα ἀνὰ 80 τετραγωνικὲς μοῖρες ἔκταση ἐπὶ τῆς ἐπιφανείας τῆς Γῆς — ἴση μὲ τὴν ἔκταση τοῦ εὐρύτερου Ἑλληνικοῦ χώρου (39°N42°, 19°E29°)—εἶναι περίπου ἀνάλογη σ' ὁλόκληρη τὴν ἐπιφάνεια τῆς Γήϊνης σφαίρας, καὶ (β) ὅτι ἡ ἀθροιστικὴ συχνότητα τῶν ἡφαιστειακῶν ἐκρήξεων σὲ συνάρτηση πρὸς τὸ μέγεθός των, ποὺ προέκυψε ἀπὸ τὰ δεδομένα τῶν μεγάλων καλδερῶν τῶν τελευταίων 4000 χρόνων, ἰσχύει καὶ γιὰ τὸ πολὺ ἀπώτερο μέλλον, ὁ χρόνος προετοιμασίας ἡφαιστειακῆς ἐκρήξεως στὸν εὐρύτερο Ἑλληνικὸ χῶρο, μεγέθους ἴσου μὲ τὸ μέγεθος τῆς Μινωϊκῆς ἐκρήξεως ἢ μεγαλυτέρου, εἶναι περίπου 400.000 χρόνια.

Ὑπὸ ἄλλη ἐκδοχή, ὅτι ἡ μέση ἡφαιστειακὴ δραστηριότητα ἀνὰ 80 τετραγωνικὲς μοῖρες ἔκταση ἐπὶ τῆς ἐπιφανείας τῆς Γῆς ἰσχύει στὴν πραγματικότητα γιὰ πολὺ περιορισμένη ἐπιφάνεια τῆς Γῆς (9% περίπου), ἰσοδύναμη σὲ ἔκταση μὲ δύο ἡφαιστειακὲς ζῶνες εὔρους περίπου 8 μοιρῶν ποὺ περιβάλλουν σχεδὸν τὴν Γήϊνη σφαίρα, ὁ μέσος χρόνος ἀναμονῆς ἡφαιστειακῆς ἐκρήξεως μεγέθους 6,9 καὶ μεγαλύτερου στὸν εὐρύτερο Ἑλληνικὸ χῶρο εἶναι περίπου 36.500 χρόνια.

Ὁ ὑπολογιζόμενος μέσος χρόνος ἀναμονῆς (36.500 χρόνια περίπου) εἶναι σὲ ἀρκετὰ καλὴ συμφωνία μὲ τὸν μέσο χρόνο ἐπαναλήψεως (33.500 χρόνια περίπου) τῶν 3 μεγαλυτέρων ἐκρήξεων ποὺ συμπαρομαρτοῦν μὲ σχηματισμὸ καλδέρας κατὰ τὰ τελευταῖα 100.000 χρόνια στὴν ἡφαιστειακὴ ἱστορία τῆς Σαντορίνης.

Ἐάν, ὅμως, δεχθοῦμε ὡς μέσο χρόνο ἐπαναλήψεως τῶν ἡφαιστειακῶν ἐκρήξεων μεγέθους VEI 6,9 καὶ μεγαλυτέρων τὰ 200 χρόνια ποὺ προέκυψαν ἀπὸ τὶς ἱστορικὲς ἐκρήξεις σ' ὁλόκληρη τὴν γήϊνη σφαίρα, καὶ τὴν δεύτερη ἐναλλακτικὴ ἐκδοχὴ γιὰ τὴν συνολικὴ ἔκταση τῆς ἡφαιστειακῆς δραστηριότητας ἐπὶ τῆς Γῆς, τότε ὁ μέσος χρόνος ἐπαναλήψεως τῶν ἡφαιστειακῶν ἐκρήξεων στὸν Ἑλληνικὸ χῶρο, τοῦ μεγέθους τῆς Μινωϊκῆς ἐκρήξεως ἢ καὶ μεγαλύτερου, εἶναι περίπου 14.400 χρόνια. Ἡ ἐκτίμηση αὐτή, ὅλως παραδόξως, εἶναι σὲ μεγάλη συμφωνία μὲ τὰ 15.000 χρόνια ἠρεμίας τοῦ ἡφαιστείου ποὺ προηγήθησαν τῆς μεγάλης ἐκρήξεως ποὺ συνέβηκε στὰ μέσα τῆς Ὀρειχαλκίνης περιόδου.

Μιὰ ἄλλη προσέγγιση τοῦ μέσου χρόνου ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων στὸν Ἑλληνικὸ χῶρο, ἴσου ἢ μεγαλύτερου τοῦ μεγέθους τῆς Μινωϊκῆς ἐκρήξεως, μπορεῖ νὰ γίνει μὲ βάση τὴν θεωρία Benioff, ὅτι ἡ θερμοκρασία ποὺ ἐλευθερώνεται στὰ βάθη κατὰ τὶς μετασεισμικὲς ἀκολουθίες ἐμφανίζεται ἔπειτα ἀπὸ πολὺ χρόνο ὑπὸ τὴν μορφὴ ἡφαιστειακῆς ἐκρήξεως. Ὑπολογισμοὶ τῆς ἐνέργειας ποὺ ἐλευθερώνεται σὲ μετασεισμικὲς ἀκολουθίες δεικνύουν ὅτι εἶναι κατὰ μέσο ὅρο περίπου ἴση μὲ τὸ ἥμισυ τῆς ἐνέργειας ποὺ ἐλευθερώνεται ὡς σεισμικὰ κύματα κατὰ τὸν κύριο σεισμό. Αὐτὸ ἐπιτρέπει τὴν ἐκδοχὴ ὅτι ἡ ἡφαιστειακὴ ἐνέργεια ποὺ ἐκλύεται κατ' ἔτος εἶναι ἀνάλογη πρὸς τὴν ἐτήσια σεισμικὴ ἐνέργεια ποὺ παράγεται στὸν ἴδιο χῶρο.

Οἱ σεισμικὲς ζῶνες στὴν ἐπιφάνεια τῆς Γῆς συμπίπτουν κατὰ τὸ μᾶλλον ἢ ἧττον μὲ τὶς ἡφαιστειακὲς ζῶνες, καὶ ἡ σεισμικὴ ἐνέργεια ποὺ ἐλευθερώνεται κατ' ἔτος στὸν εὐρύτερο Ἑλληνικὸ χῶρο εἶναι περίπου 2% τῆς συνολικῆς κυματικῆς ἐνέργειας ποὺ ἐλευθερώνεται ἐτησίως σ' ὁλόκληρη τὴν ἐπιφάνεια τῆς Γῆς. Ἐὰν υἱοθετήσουμε ὡς περίοδο ἐπαναλήψεως τῶν ἡφαιστειακῶν ἐκρήξεων μεγέθους 6,9 καὶ ἐπάνω τὰ 300 χρόνια ποὺ προέκυψαν ἀπὸ τὴν ἀνάλυση τῶν ἱστορικῶν καὶ προϊστορικῶν ἡφαιστειακῶν δεδομένων, τότε ἡ μέση περίοδος ἐπαναλήψεως ἡφαιστειακῶν ἐκρήξεων, ἀντιστοίχου μεγέθους, στὸν Ἑλληνικὸ χῶρο, εἶναι 50 φορὲς μεγαλύτερη, δηλαδὴ $50 \times 300 = 15000$ χρόνια. Τοῦτο ἀντιστοιχεῖ ἀκριβῶς στὸ χρονικὸ διάστημα ποὺ βρέθηκε διὰ ραδιοχρονολογήσεως ὡς περίοδος ἀναπαύσεως τοῦ ἡφαιστείου ποὺ προηγήθηκε τῆς Μινωϊκῆς ἐκρήξεως.

Ὁ ὑπολογιζόμενος μέσος χρόνος ἀναμονῆς (15.000 χρόνια περίπου) προσεγγίζει ἱκανοποιητικὰ τὸν μέσο χρόνο ἐπαναλήψεως (16.500 χρόνια περίπου) τῶν 6 μεγαλύτερων ἡφαιστειακῶν συμβάντων κατὰ τὰ τελευταῖα 100.000 χρόνια στὴν ἱστορία τῆς Σαντορίνης.

Ὅλοι αὐτοὶ οἱ ὑπολογισμοὶ ὑποδεικνύουν ὅτι ἡ Μινωϊκὴ ἔκρηξη ἐπὶ τῆς νήσου Θήρας ἦταν τόσο πρωτόγνωρη σὲ μέγεθος καὶ ἀποτελέσματα στὴν εὐρύτερη περιοχὴ τοῦ Ἑλληνικοῦ χώρου καὶ στὰ παράλια τῆς Ἀνατολικῆς Μεσογείου, ὥστε νὰ διασωθεῖ

ἡ ἀνάμνησή της ἐπὶ πολλοὺς αἰῶνες. Ἡ ἀνάμνησή της παρέμεινε, κυρίως, ὡς κτυπητὸ διδακτικὸ παράδειγμα *Θεομηνίας*, δηλαδὴ τιμωρίας ὑπὸ τῶν Θεῶν τῆς ἀχαριστίας, ἀλαζονείας καὶ ἀνομίας ἢ ἄλλων κακῶν πράξεων τῶν ἀνθρώπων, ὑπὸ τὴν μορφὴ παραδόσεων ἢ μύθων, μὲ πυρήνα μικρὸ ἢ μεγάλο διάφορα φυσικὰ φαινόμενα πού παρατηρήθηκαν κατὰ τὴν ἔκρηξη αὐτή, ἐμπλουτισμένων μὲ τὴν πάροδο τοῦ χρόνου μὲ μεταγενέστερες ἐμπειρίες καὶ ἀναπόφευκτες συγχύσεις ἀπὸ διαφόρους ποιητὲς καὶ ἀφηγητὲς περὶ Ἀτλαντίδας, Κατακλυσμοῦ τοῦ Δευκαλίωνα, Φαέθωνα, Ἱππόλυτου, Πληγῶν τῆς Αἰγύπτου καὶ Ἐξόδου τῶν Ἰσραηλιτῶν, ἴσως δὲ καὶ μερικῶν ἀποσπασμάτων τῆς Ἀποκαλύψεως.

APPENDIX

It is worth noting that some fragments of Prophesies in the book of Jeremiah are quite similar to those of the Revelation of St. John; Solon (635-558 B.C.), whose notes were used by Plato in his dialogues Timaios and Kritias for the Legend of Atlantis, was contempory with Jeremiah (650-585 B.C.).