

Crack Propagation and Fracture of hard Rocks and Earth and Space Sciences

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ABSTRACT: Laboratory tensile fracture toughness testing on the short rod specimen of Kallax gabbro and Bjorka marble was performed. Servo-controlled loading was employed to obtain the complete load versus crack mouth opening displacement (CMOD) curve. Acoustic emission (AE) and microscopic measurements were also made. A fluorescent dye was used to trace crack propagation. It was found that the main crack was formed by crack propagation, bifurcation and looping. Although one main crack would eventually separate a specimen into two halves, the rock material in the vicinity of the crack sustained microscopic damage. Inspired by the findings and with the use of a Planet Finder software, studies of weather and other natural changes on earth as well as global warming and pollution, weather bifurcation, rock stresses, earthquakes and rockbursts, and the origin of energy and mineral resources were performed. Earth science and mining engineering in the Chinese and English languages is also discussed. The findings can be applied to the ground seepage studies of ground water, oil, gas, industrial and medical waste, pesticide or other chemical solutions. The findings can also be applied to study rock damage and failure due to stresses, rock breakage and blasting, treatment of rock surfaces, materials science and underground or ground constructions. It is found that the earth is like a servo-regulator for at least a part of the solar system due to the abundance of water. This would remind the human kind on earth of more prudence and responsibility than ever realized. Effective measures must be taken to stop global pollution and warming in order to prevent the occurrence of disasters and conserve the earth for our own happy longevity and that of the generations to come.

1 INTRODUCTION

The resistance of a material to crack initiation, propagation and brittle failure is measured by the fracture toughness material property parameter. The standard Short Rod Chevron Notched Core Specimen geometry for the determination of rock fracture toughness was employed in the laboratory to study crack propagation and acoustic emission (AE) characteristics in 71.4 diameter specimens (Fig. 1). Studies of cracking in microscope revealed certain microscopic damage on grain boundaries and across grains in the vicinity of the main cracks (Yi 1987 and 1989). The accurately recorded and measured data helped understand the fracture mechanisms of hard rocks. The results were the basis for further studies. Knowledge of geography, daily observations of ecosystems, use of a Planet Finder software (Crowell 2003) and the analysis of the Chinese and English languages were employed to understand how the planetary factors and human actions affect

the natural changes on the earth such as ocean tidal waves, wind, rain, river flow, global warming and pollution, extreme weathers, rockbursts and earthquakes.

2 LABORATORY EXPERIMENT

2.1 Brief Introduction to Fracture Mechanics

The fracture toughness for the short rod specimen geometry in Fig. 1 is essentially expressed as (Yi 1987 and Yi et al. 1991):

$$K_{SR} = A_{min} (F_{max}/D^{1.5}) \quad (2.1)$$

where A_{min} is a dimensionless geometry constant, D the specimen diameter and F_{max} the peak load from the testing. In fracture mechanics theory, the linear elastic stress intensity factor at a crack tip for opening mode is expressed as (Wikipedia 2006):

$$K_I = Y \sigma (\pi a)^{0.5} \quad (2.2)$$

where “Y” is a dimensionless geometry factor that is close to 1.0, “ σ ” the stress normal to the crack, and “a” the half crack length. If, K_I exceed K_{SR} , the crack begins to propagate.

2.2 Specimen Preparation and Test Setup

Fig. 1 shows the specimen geometry. The Chevron shape was designed to permit stable steady state crack propagation for a certain length. For the series A and B Kallax gabbro specimens, cores were bored from large blocks of rock in the laboratory. Bjorka marble specimens of Series C were prepared from existing cores of marble obtained from the Bjorka mine in central Sweden. The Kallax gabbro was black in color and the Bjorka marble was white gray. Two series of Kallax gabbro were made. Series A testing was a trial by which an appropriate experimental method was found for the other series of testing. The specimens in Series A were 71.4 mm diameter and were drilled from block A of Kallax gabbro. The specimens of Series B were 71.3 mm in diameter and were drilled from block B of Kallax gabbro. All cores were oriented in the same direction and the notches in all the specimens were cut at the same orientation with respect to the rock block. Bjorka marble specimens were 71.5 mm in diameter. The effect of rock grain orientation on crack propagation was not investigated. The mineral composition of the rocks is shown below.

Kallax gabbro: Pyroxene 15-20%, Feldspar 70%, Olivine 5-10%, Opaque minerals 1-2%, Grain Size <1mm.

Bjorka marble: Carbonate (Dolomite + Calcite) 92%, Mica (Phlogopite) 8%, Grain Size 0.2-3.8 (average 1.1) mm.

An Instron Model 1342 type stiff and servo-control testing machine with a loading capacity of 100 kN was used to obtain the complete load versus CMOD curve. In order to permit load application, aluminum alloy plates were glued to the front end of a specimen as shown in Fig. 2. The tests were controlled by means of the crack mouth (notch mouth) opening displacement (CMOD). Load versus CMOD curves were plotted with pen plotters. A string was suspended from the cross head of the press to hold the weight of the specimen. The weight of a Kallax gabbro specimen was 1.26 kg and that of a marble specimen was 1.36 kg.

2.3 Acoustic Emission (AE) Monitoring Technique

The Dunegan/Endevco 3000 Series type of acoustic emission device was used (Fig. 2). The transducer was model D9203. The Pre-amplifier was model 801 P. A model 301 Totalizer was used to record the ring-down count rate of the AE signals. The AE

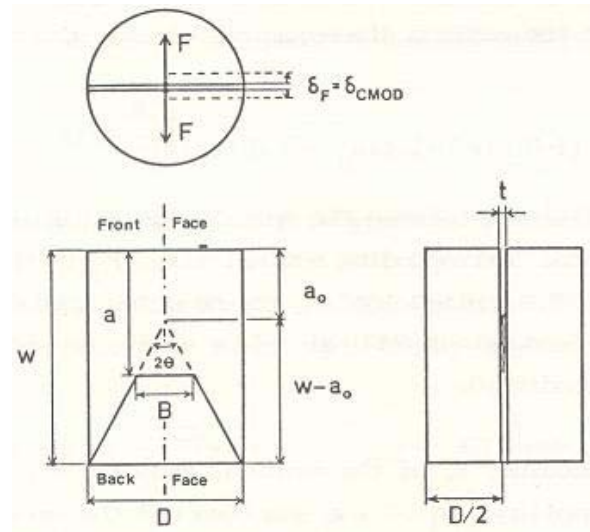


Figure 1. The standard short rod chevron notched (V-shaped) core specimen (ISRM). D = Diameter of specimen; w = Length of specimen, $w/D = 1.45 \pm 0.02$; 2θ = Chevron angle, $54.6^\circ \pm 1.0$; a_0 = Chevron tip position, $a_0/D = 0.48 \pm 0.02$; t = Notch width, $t/D < 0.03$.

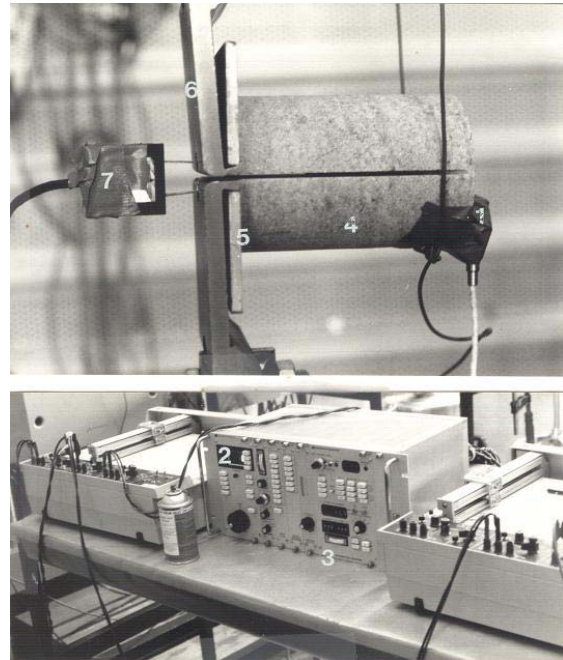


Figure 2. Test setup and acoustic emission instrumentation, where (1) is the AE transducer, (2) totalizer, (3) distribution analyzer, (4) rock specimen, (5) aluminum alloy end plates, (6) loading steel plates, (7) crack opening gauge.

ring-down count rate is the number of waves whose amplitudes are greater than a reference value. It is a relative value that is a function of the gain (magnification) of the measuring device. The gain was a value set internally. In Series C tests on Bjorka Marble specimens, an additional AE parameter, the amplitude distribution, was recorded by utilizing the model 920 Distribution Analyzer and the Model 921A Amplitude Detector. The parameters on the Model 301 Totalizer were chosen as follows:

Multiplier was 100 for Series A and B Kallax gabbro specimens, and 10 for Series C marble specimens. Filter was 0.3 - 1.0 MHz. Plotting mode was MEM (step plotting). The gain was 40 dB except 50 dB for specimen No. A-4. Time span was 1 second. The frequency range of 0.3 to 1.0 MHz was selected to represent AE from micro cracking in rock materials.

2.4 Testing and Fluorescent Dye Application

Every specimen was loaded to a certain load level whose position on the complete load versus CMOD curve was indicated by the numbers shown in Fig. 3,

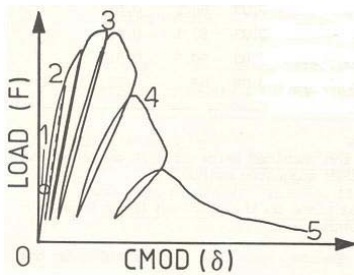


Figure 3. The unloading stages shown on a typical load versus CMOD curve. (1) Beginning of nonlinearity; (2) Middle of nonlinearity; (3) "Peak" load; (4) Maximum AE point in the post peak regime; and (5) "End" of complete curve.

which could be obtained with servo-controlled testing. The servo-controlled load is one that is automatically adjusted according to specimen resistance to achieve the preset displacement per unit time. After the predetermined load was reached, an unloading-reloading cycle was performed, and then the test was transferred from strain to the more stable position control. A fluorescent dye of low viscosity (Penetrant ZL 22A, ZYGLO) was injected into the notch with a long spray needle. This crack tracing method did not work for the Series C marble specimens because the dye diffused into the grain boundaries and pores inside the grains. After the injection of the fluorescent dye, the specimen was taken off the testing machine. With the sides of the notch sealed off with a tape, an epoxy (HY 994, AW 136 H) mixed with a small quantity of fluorescent liquid was injected into the notch from the front face of the specimen. This precaution was taken to prevent any undesired crack growth in later specimen cutting. The use of the additional fluorescent liquid made the epoxy in the notch visible under ultraviolet light.

2.5 Crack Measurements after Testing

An epoxy cured specimen was bolted to a thick steel plate through the two aluminum alloy end plates in order to be sliced in a diamond wheel rock cutter. The width of the cutting was 2.5 mm. The thickness of the slices was between 4 and 8 mm. The rock

slices were then examined and photographed under ultraviolet light under which the fluorescent dye appeared in green color (Fig. 4). The surfaces of the slices were photographed on color film by two methods, one with a personal Nikon EM camera and another in an optical microscope. On photographs obtained from both methods, a transparent millimeter scale was placed on the slice surface along the crack for millimeter reading.

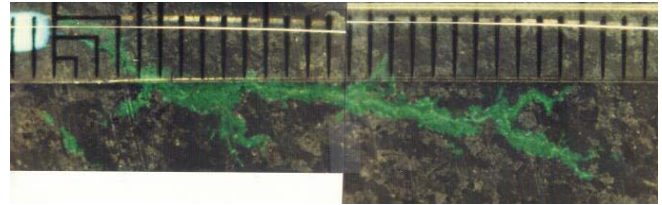


Figure 4. Surface 2A of slice 2 from Spec A-7. (color photo)

The optical microscope had a maximum magnification of 50. The photographs for crack length measurements were taken with 6-fold magnification. A number of successive frames were taken to obtain the complete picture of the crack on a slice. By using the millimeter scale, frames of a crack could be readily assembled. Higher magnifications of the microscope were occasionally used to examine a crack in more details. The error in measured crack length was around 1 mm, or between 0.01 and 0.02 in the ratio of the crack length to specimen diameter (a/D). The error can be larger if the crack tip position was uncertain due to a thin fluorescent cloud at the crack tip. The crack length (a) measured by the method depended to a certain degree on the permeability of the fluorescent dye to reach the crack tip. For the Kallax gabbro, it reached further than human visibility under a microscope. The measured length contained most if not all the micro-cracking damage zone. The measurement was therefore more accurate than that measured on a granite without the use of a tracing dye (Labuz et al. 1985).

For Bjorka Marble specimens, the two types of fluorescent dye permeated through the rock grain boundaries and grains near the crack. The location of the crack tip could not be determined under the ultra-violet light. However, a portion of the crack was visible under normal light with naked eyes when a film of water was wiped on a slice surface. The microscope did not help trace a crack tip further than the naked eyes on an unpolished surface. On a polished slice, the crack was sometimes traced further with the use of an optical microscope under normal light. The error in the determination of crack tip location may be up to 3 mm or 0.04 in the ratio of the crack length to the specimen diameter (a/D). It should be noted that a crack on the marble surface

was easier to trace than on the gabbro under normal light. The polishing of marble slices was done with grinding particles of mesh number 600 in the PM2 Precision Polishing Machine (LOGITECH LTD, Scotland). The microscope magnification was from 6 to 100-fold. A larger magnification did not help trace the crack further due to the presence of grain boundaries that looked like micro-cracks.

2.6 Kallax gabbro Thin Section Microscopy

There was a special technology to prepare the thin rock section of thickness in micrometers. A thin section was impregnated in vacuum with a fluorescent dye (fluorescein sodium powder, alcohol and an epoxy of low viscosity from Epo-Tek, Sweden). The micro-cracks appeared green under ultra-violet light. The grains and boundaries were clearly visible under polarized light in the microscope with 10 to 70 magnification. This technology could not be used for the marble because the grain boundaries and pores would be filled with the fluorescent dye. The Kallax gabbro had no preexisting microscopic cracks and pores such that the fresh micro cracks were clearly identified. The thin section in Fig. 5 was prepared from Specimen A-7 of Series A and it was photographed under normal light. This specimen had been loaded to the post-peak regime (Fig. 3). The thin section area included the crack tip region and the back end of the specimen (vertical end on the right hand

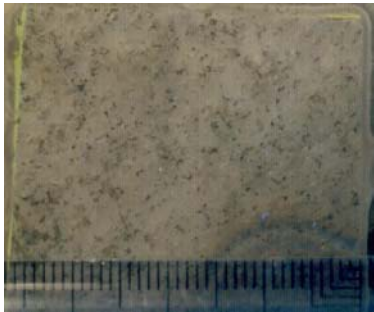


Figure 5. Color photo of the rock thin section of Kallax gabbro. The right hand was the specimen back face (Fig. 1). The bottom was a millimeter scale. The arch shaped mark on the bottom right corner was on the support surface underneath.

side of Fig. 5). The thin section was about 36 mm in length in the direction of crack propagation, and it was partially transparent under normal light. The thin section microscopy verified that the above crack length measurement method for Kallax gabbro was accurate to 1 mm.

3 EXPERIMENTAL RESULTS AND ANALYSIS

3.1 Cracks in Kallax Gabbro and Bjorka Marble

Crack length was measured with a millimeter scale in the direction of the notch regardless of the crack waviness, and the maximum deviation from the

notch plane was noted. The curve connecting the crack tip positions measured on different slices of the same specimen was called the crack front. Measured crack fronts in the six specimens of Series B gabbro specimens are presented in Fig. 6.

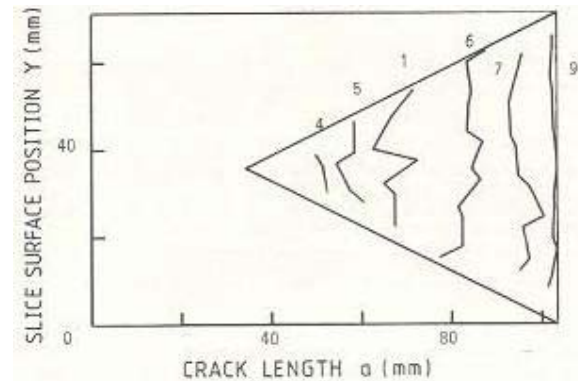


Figure 6. Crack front curves in Kallax gabbro specimens of Series B.

It was observed that the cracks have many bifurcations but no more than two branches at any point on the crack. Only one main crack could propagate to the specimen back end face. Unloading lines on the load versus CMOD curve were used to calculate or estimate the crack length with established method. The estimated crack lengths were compared to the measured crack length (Yi 1987 and 1989). The main findings were:

- (i) the crack length calculated from the unloading tangent compliance (stiffness) equals approximately the traction free crack length; (ii) the crack length calculated from the secant tangent compliance (stiffness) equals approximately the entire crack length; and (iii) the difference between the measured crack length and that calculated from the unloading tangent compliance equals approximately the fracture process zone length. The fracture process zone length in the 71.4 mm diameter short rod Kallax gabbro specimens at Loading stage 4 (Fig. 3) was approximately 10 mm.

Although cracks on certain polished Bjorka marble slice surfaces could be traced further by 1 to 4 mm than unpolished surfaces, it was found that the two types of measurements did not differ in statistical significance. Unlike the Kallax gabbro specimens, the measured crack length for Bjorka marble specimens equals approximately the crack length calculated from the unloading tangent compliance (stiffness). The cracks in the Bjorka marble specimens deviated less from the notch plane than the Kallax gabbro specimens. Therefore, the fracture process zone was either not identified with the specific experimental technique, or it was insignificantly small. This was probably due to the less brittle or more ductile material property for the Bjorka marble.

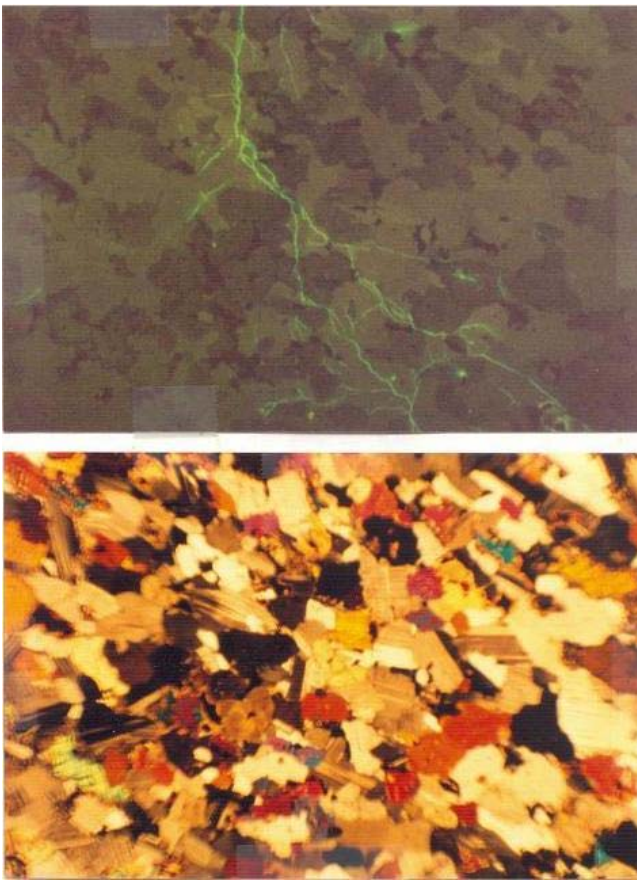


Figure 7. Color photographs of the last big bifurcation of the crack on the thin section, where the top picture was photographed with transmission ultra-violet light; and the bottom picture with polarized light (Magnification 10). Note that the specimen back face is located at the bottom of the pictures, cf. Fig. 1 and Fig. 5.

3.2 Micro-Cracks in Kallax Gabbro

Fig. 7 shows a microscopic view of the last crack bifurcation area next to the crack tip on the thin section. This last bifurcation point was approximately 12 mm from the back face of the specimen. There was lots of crack bifurcations and a few loops. From observations of all specimens, it was clear that if it were to be loaded further, only one of the two major bifurcations would propagate to the back face of the specimen. The looping or bifurcation did not occur on grain boundaries but occurred within the grains. It was estimated that 99% of the micro cracks ran across the grains, and the rest ran along grain boundaries. The loop next to the last bifurcation point had a small loop in it. On the crack mouth (notch) side, there was a dominant crack despite the loops and bifurcations; but near the crack tip at the last big bifurcation point, a dominant crack did not form yet. This segment of about 12 mm length probably accounted for the fracture process zone length.

3.3 Characteristics of Acoustic Emission (AE)

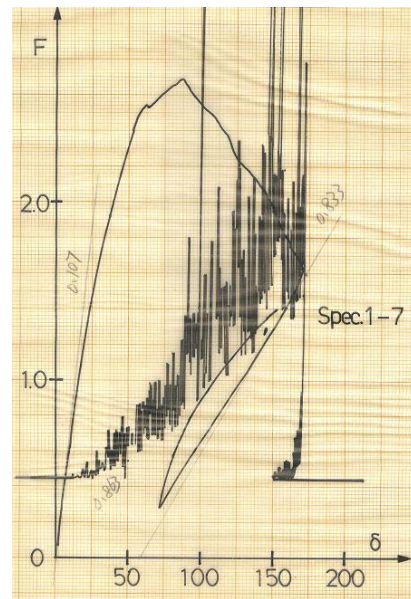


Figure 8. Load and acoustic emission (AE) count rate versus displacement curves for Specimen A-7. (color scan)

The curves showed that the AE count rate initiated at a small load. It increased gradually to reach its maximum in the post peak load regime. The AE count rate dropped off drastically as soon as unloading began, but, not to zero.

Fig. 8 shows the load and AE count rate versus CMOD curves. These two parameters were also plotted against time. The plots showed that AE Maintained at a very small value during the unloading time period, with the amplitude being equivalent

to the initial AE. This little AE was possibly due to the closure of the damaged crack surfaces during unloading. The AE dropped to zero when reloading began. This AE silence accompanied the non-linear portion of the reloading load-displacement curve. The AE increased again as soon as the reloading curve progressed to a linear curve. In Series B tests on Kallax gabbro specimens, the initial AE started at a load of 21 to 30% peak load (5 data). The maximum AE occurred in the post peak load regime at a load of 66 to 53% peak load (2 data). For the Series C Bjorka marble specimens, the corresponding values were 21 to 32% (5 data) and 70% for Specimen C-5 (1 datum). This would suggest that in the Bjorka marble, the maximum AE occurred closer to the peak load than the Kallax gabbro. Another definitive difference between the two types of rocks is that the magnitude of the AE in the Bjorka marble was only 1/10 of the Kallax gabbro. The AE count rate parameter was a combined indicator for both the number and the frequency of acoustic waves generated in the cracking. This is another evidence to suggest that the marble material is less brittle than gabbro.

3.4 Fracture Toughness of the two types of Rocks

The load versus CMOD curve was used to calculate and evaluate the fracture toughness and Young's modulus of a specimen. The crack opening mode elastic level I fracture toughness is a function of

peak load and specimen geometry. The evaluation method and results were presented elsewhere (Yi 1987 and Yi et al. 1991). The peak loads obtained for the specimens were 2.47 ± 0.17 (5 data for Series A gabbro), 2.20 ± 0.32 (5 data for Series B gabbro), and 1.06 ± 0.16 kN (4 data for Series C marble). The level I fracture toughness values were 3.25 ± 0.22 (Series A gabbro), 2.63 ± 0.13 (Series B gabbro), and 1.30 ± 0.20 MN m^{-1.5} (Series C marble) respectively. In other words, the Kallax gabbro is more than twice as tough as the Bjorka marble. The corresponding Young's modulus values for the three series were: 107 ± 5 (6 data), 81 ± 4 (6 data), and 33 ± 3 (5 data) MPa, respectively. The Kallax gabbro is more than twice as stiff as the Bjorka marble.

4 DISCUSSION

4.1 Fracture Toughness and Crack Propagation

The above results indicate that the fracture toughness of a hard rock is somewhat proportional to the peak load for a given specimen size, the elastic modulus and the brittleness. On the other hand, the density of the Kallax gabbro was slightly less than the Bjorka marble. Barker (1983) demonstrated that a crack front in the short rod specimen of a fused quartz material has a slight arch shape in the direction of crack propagation. This property was not detected in the rock specimens. Ouchterlony and Sun (1983) obtained a fracture toughness of 1.87 ± 0.15 MN m^{-1.5} and Young's modulus of 86 GPa for Ekeberg marble. Ekeberg marble was similar to Bjorka marble in mineral composition, but with an average grain size only half of Bjorka marble. The Kallax gabbro and the Bjorka marble have similar grain size and density but quite different fracture toughness.

Crack microscopy showed that the fracture process zone in Kallax gabbro was different from that in Bjorka marble. The fracture process zone in Kallax gabbro was from 10 to 12 mm and it consisted of connected micro-cracks and is different from a plastic or yielding zone. The unloading-reloading curve for Bjorka marble was less linear than for Kallax gabbro. The fracture process zone for Bjorka marble was very small. Therefore, the fracture process zone of micro-cracks in Kallax gabbro should not be treated as crack tip plasticity (Hutchinson 1979) but as a crack tip with linear stress distribution (Yi 1989).

The maximum AE occurred in the post peak load regime for both Kallax gabbro and Bjorka marble, but

more so for Kallax gabbro. In Kallax gabbro, it occurred at 66 to 53% peak load at Stage 4 on the load versus CMOD curve (Fig. 3). This indicated that the fracture process zone increased after the peak load was surpassed. Thin section microscopy showed that the crack pattern became more complex in the post-peak load regime. This was partially attributed to the small crack area in the pre-peak load regime because of the designed Chevron notch shape (Fig. 6). The Chevron shaped crack area looks a little like a sharp volcano mountain peak that is subject to cold wind erosion. A crack in Kallax gabbro was formed by crack propagation, micro-cracking, bifurcation and looping. Bifurcation means that there exist no more than two branches at any point on the crack, and looping means that the two branches grow to meet again at a point further ahead. The fact that no more than two branches occur at any point may be a consequence of the simple tensile loading condition in which the applied tensile load was balanced by the rock resistance on the plane of the crack. This crack propagation process is a typical tensile brittle failure. The crack propagation in the less brittle marble was more straightforward. This explains why certain tough hard rockmass such as the pink feldspar porphyry rockmass at Hemlo Mines of Canada contains joints and fractures with mineral infilling.

4.2 Rock Stress and Stress Induced Damage

If the testing were not servo-controlled, i.e., the applied load could not decrease with decreasing resistance, the crack would have propagated dynamically at high speed after the peak load was attained. There would be insufficient time to record all the AE signals beyond the peak load. The complete curve in Fig. 3 would not have been obtained. Compared to the Bjorka marble, the Kallax gabbro exhibited more "after shocks" behavior. The type of loading in an earthquake or rockburst in different rock structures may differ in a wide range from servo-controlled to uncontrolled or free loading. Dead weight loading with a rock block is a kind of dead weight or free loading.

Rock failures due to mining induced stress concentrations were observed in underground mining. Drill cores from a production stope where massive rock failure occurred in the Williams mine of Ontario, Canada show broken cores and thin rock discs in the rockmass that had been subject to severe stress damage (Fig. 9).



Figure 9. Photograph of drill cores from a highly stressed stope near a caved void at 900 m depth in Williams Mine. It shows five sixth of the panel length holding the rock cores. The cores in the last 15 m length near the caved opening were fractured with reduced values of RQD (Rockmass Quality Designation). The closer it was towards the caved opening, the more damaged the rock cores were.

Under confined high stress conditions deep in the earth, the failure mode may be more ductile than brittle (Judd et al. 1964 and Hoek and Brown 1980). Besides traditional methods of stress and structural analyses, the number of seismic events or small earthquakes in a certain rock mass per lunar month, year or other cyclic time unit and their accumulative effects may help predict, prevent or avoid large rockbursts or earthquakes. However, accurate prediction of earthquakes and rockbursts in the time domain is a challenge.

The experimental setup in Fig. 2 is somewhat like the tidal wave loading of the Baja peninsula and the Colorado river in the north of the Gulf of California of Mexico (Fig. A-1). The state of stresses may change between tensile, compressive and shear with seasonal changes. The islands of Hawaii and the little islands off the coast of Baja state of Mexico and Long Beach city of California remind us of the land lost in many parts of the world, such as the islands between Australia and Asia and in Central America, due to global warming and strong tidal wave and wind forces.

4.3 Planets and Weather Changes

The author used the Planet Finder software (Crowell 2003) to study the weather in San Rafael and Los Angeles, California. It was found that the positions of the Sun and the Moon (and other planets) in the sky definitively correlated with the weather changes such as wind, tidal waves, cloud, rain, and river flow. The dynamic actions of tidal waves on the shallow sand beaches and steep rock cliffs of the Pacific ocean coastline generates water bubbles and

fog in different amounts. Wind carries the fog to the land of California as far as the Sierra Mountain Range. The tidal wave forces on the coastlines and the wind forces over the mountains are the main direct driving forces for the earth's west to east self-rotation. Such forces are related to sunlight and moonlight. The earth's self-rotation is also affected to a certain extend by river flows. It should be born in mind that the velocity and amount of water flow in rivers change in monthly and yearly cycles. At one extreme, there is flooding and the water flow exerts much forces on the banks of the rivers, and on the other extreme, the water flow may stop and the direction of flow may even be slightly reversed. Thus, the adverse impact of hydroelectric water dams on the fish, water plants, and water evaporation is far reaching over time.

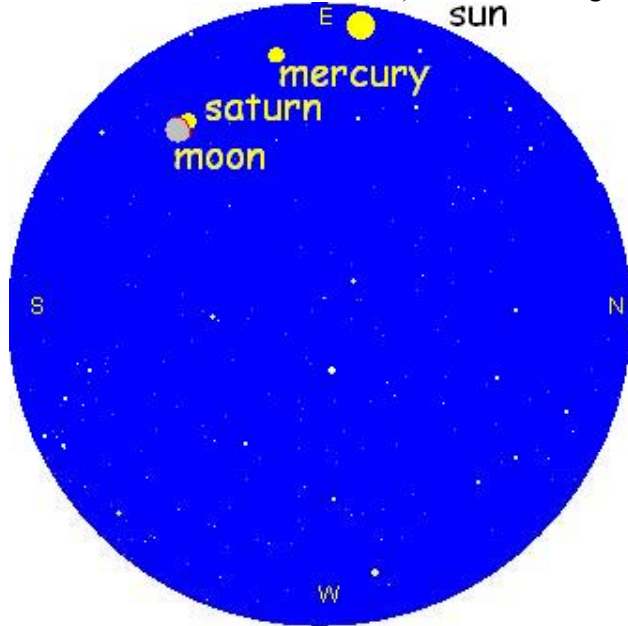
The seasonal weather changes sometimes caused the occurrence of earthquakes. The following are two of the simplest rules concerning the weather effects of the sun and moon: (1) When the moon and the sun come together in the sky to form an acute angle (which usually lasts 3 to 7 days), the daytime sunshine is strong and the western wind may bring in cloud, strong ocean tide and rain at and after sunset; and there is more temperature difference between day and night. (2) when the moon is on the opposite side of the sun to form about 180 degree angle (about 12 hour time difference), the energies from the moon and the sun in the opposite directions effectively reduce the west to east or east to west wind; the sun and the moon shine alternately during the day and the night to keep the earth warm day and night; and this in the extreme would make it possible for the wind in the southern or northern direction to cause weather changes such as high ocean tidal waves, rain or snow in different parts of the earth.

4.4 Earthquakes and Rockbursts due to Weather Changes

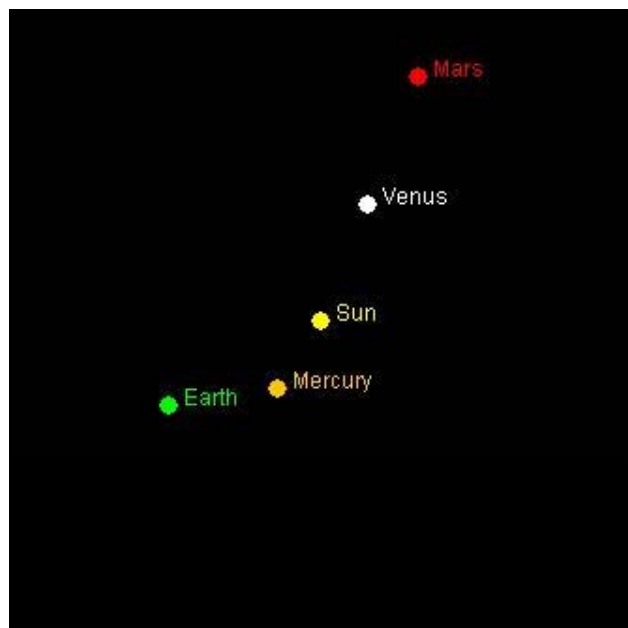
The rule number (1) in the previous section explains in part the 1906 San Francisco earthquake of an estimated magnitude 8.25 Richter scale (Fig. 10). It also explains in part the year 2002 Gilroy earthquake of 5.2 Richter scale (4.9 Moment scale) in San Francisco Bay which the author observed in San Rafael (Fig. 11). This small earthquake was located at 7.6 km (4.8 mi) depth and about 130 km from where the author lived in San Rafael. The author lived on the second floor of an old three storey wood painted apartment building on the rocky Harrison Barbier hill slope facing south-west near China Camp State Park in San Rafael of Marin county. The earthquake

shake lasted for a few seconds and it appeared as north-south swing movement. The large front glass window in aluminum frames generated noise, which sounded like the action of heavy wind. The author would not have recognized the small earthquake without the immediate television report. The neighbor in the first floor apartment below later described it as sideways movement in comparison to the usual up and down movement in previous small earthquakes.

The rule number (2) in the previous section explains the year 2004 Parkfield earthquake of magnitude M6 in southern California (Examples of Earthquakes 1906-2004 and Li et al. 2004). Since the great



(a)



(b)

Figure 10. (a) Shows the San Francisco dawn sky at time 05:15 am on April 18, 1906 at the time of the 8.25 Richter scale earthquake (moon to sun 3 hours). Notice the transit of the moon on Saturn. (b) Shows the inner planets Mercury, Venus and Mars lined up with the sun on one side of the earth in the solar system. See Fig. A-5 for outer planets. Plotted with Planet Finder software by Crowell (false color).

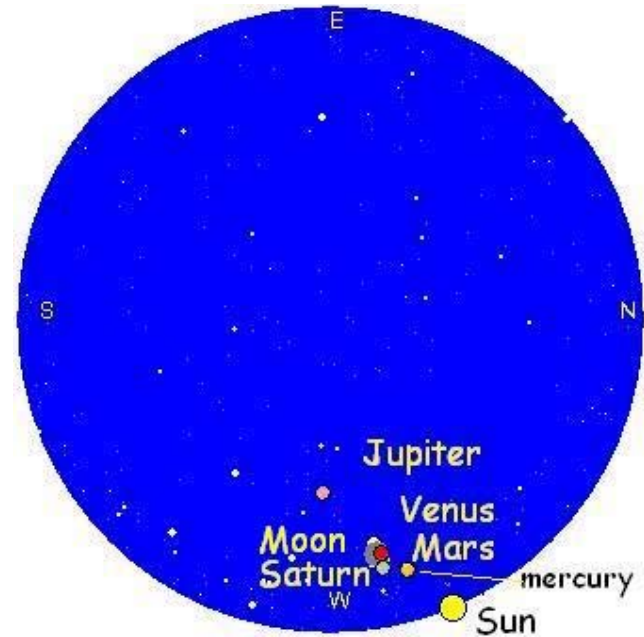


Figure 11. San Rafael night sky at time 20:00 that is two hours before the time for the small Gilroy earthquake at 22:00 pm on May 13, 2002 (moon to sun 2 hours). Notice the transit of the moon on Venus, Mars and Saturn. (false color plots)

lakes on the border of Canada and USA act like seas, the rockbursts in the mines in the vicinity may also be explained in part by the planetary pattern of the solar system. For examples, rule (1) above explains in part the two 2003 Sudbury rockbursts of magnitude Mn 2.2 and 2.7. Rule (2) above explains in part the year 2002 Mn 1.8 Sudbury and the year 2003 Mn 3.5 Hemlo rockbursts (Examples of Rockbursts 2002-2003). Besides the above regional stress effects, rain causes ground water increases that may influence the occurrence of rockbursts or earthquakes. The self-rotation force that the earth's crust is subject to is somewhat analogous to the pulling force in the rock specimen testing. Such self-rotational force maintains the earth's travel speed and self-rotational velocity. The force is in balance with the resistance or strength of the earth's crust. Seismologists generally treat an earthquake or rockburst as a shear slip on existing geological features. Such rock shear failure would generally involve localized "up hill climbing" or "down hill slip" on asperities and the breaking of some of these asperities and certain other interlocking segments. The breaking of asperities and intact rock segments would be similar to the tensile cracking of intact rocks. On the other hand, in very high stress conditions, under-

ground rockbursts can also occur under very high stresses in the absence of major geological features.

4.5 *Science in the Chinese Characters and English Letters*

The ancient book of Yi  (Yi Jing - I Ching – Zhou Yi) is probably the earliest written story that was passed down unaltered (written in 2852 B.C. by Fu Xi) (Fig. A-6). It was later used as a book of divination (Legge 1882, Siu 1968, Shi and Qiu 1994). It was the origin of both the character based visual and alphabet based spelling languages of the world. The title “Yi” represented the beneficial universe from heaven to earth such as the sun, the moon, the forest mountains and the trees, and the rivers and lakes of water, etc. At the first glance, this Chinese character looks like a person walking. It also reminds of other walking, flying and swimming creatures. The Chinese character for a human  Ren looks like the side view of a person walking with two legs. The letter “Y” is an upside down view of this character. The pronunciation for “Ren” in DongAn dialect of southern Hunan province of China is “Xing”, which sounds the same as the basic Chinese characters for walking, flying or swimming. This character “Ren” was likely simplified from the Chinese character “ Yi”. The entire 26 letters of the pinyin of English alphabet was derived from this character.

Likely in the Chinese Zhou dynasty, the above book was given the double words title “Yi Jing”  or “Yi King”. It sounds like the Chinese  in the Cantonese dialect and the Swedish language. The letter “Y” was separated into “VI” which was used for “VI KING” in Sweden. It is no surprise that “VI” was used for the number 6 that are the number of lines in a hexagram of Yi Jing. The three letters of “y, I, e” together with the three additional vowels of “a”, “o”, and “u” that are visually related to “e” (upside down) and “v” (from y), constitute all the words in both Chinese and English languages. Most likely, the “Jing” or “King” in the title was an imitation of the first trigram “Qian”. The English word “Queen” likely came from the second trigram “Kun” (Fig. A-6).

In the English and Chinese languages, a human is often defined as a “bipedal high class creature”. Humans have excelled in making and using tools but moved slower than many beasts and birds by nature. So far in history, this definition has remained essentially valid. Some humans have made swimming, rolling and flying machines to emulate beasts and birds. These man made machines were not intended

to replace the animals. The human kind is at a cross road of change from relying on natural, human and animal power to inorganic machine power.

The first 8 characters or trigrams of Yi Jing were known as Yi Jing Ba Zi, that is, “Qian Kun Tun Meng Xu Song Shi Bi” (Fig.A-6). These Chinese characters look like the sketches of 8 different sceneries, that is, Yi Jing, of a typical Yi village, that is “Yi Li”, at about 2852 B.C.. They were later used to classify the 8 kinds of work at that time. Such work classification is explicitly shown in the Chinese character  (Jing). The number “9” is pronounced “Jiu” that sounds similar to “Zhou” in Chinese. The symbol “o” for a circle that is contained in “9” is pronounced as “Zhou”. Since the Chinese Zhou dynasty, Yi Jing was also known as “Zhou Yi”. This indicates that the title “Yi” plus the 8 characters existed first. It is unknown when the 9 characters were expanded to the 81 (including the title “Jing”) characters. The number 4 also contains a loop, which would indicate that the 4 biographs existed before the trigrams (Fig. A-6). It is unknown when the 4 biographs were expanded to the 8 trigrams. Likely since the Chinese Zhou dynasty, an additional 64 classifications of borderline work were added to the original 8 kinds of work to constitute what was popularly known as the 72 classifications of work. The 72 kinds of works were also used for the 72 changes that the Monk Sun WuKong was able to make (Wu ChengEn, Tan Dynasty).

The 81 Chinese characters and 64 hexagrams of Yi Jing contained the 1, 2, 3, 4, 5, 6, 8, 9, and 10 base number systems which were represented by the linear sequence, biographs, trigrams, Chinese 5 words and 4 words poetry, hexagrams, 72 kinds of works, and the 60 hexagrams from “Qian” to “Jie”. The 6-base number system was used for angle measurement ($6 \times 10 \times 6 = 360$ degrees for a circle). The spelling of the Chinese characters in Yi Jing contained all 26 letters of the English alphabet. The trigrams or three line graphs of Yi Jing were the origin for the Korean spelling language and other alphabetical languages of the world. The English word “GOD” referred to the positions of the three horizontal lines, that is in Chinese, “Gao Zhong Di” (High, Middle, Low). “GOD” is firstly related to “Garden Of eDen” and secondly to “GO”. Its three constituents “Father, Son, Holly Spirit-Ghost” referred to “Feather Birds on high, Mountains in the middle, Clean Water at low places”.

The word “Change” in the English title “Book of Change” for the book was derived from the personal

name “Jiang Zi Ya” or “Jiang Yi” who practiced Yi divination at the time of 1134 B.C.. He was one of the founding general of the Zhou dynasty. The translation of “Yi” to “Change” was not the best. A better translation of “Yi” into English is “Beneficial Change”. In the English translations, the Chinese characters were omitted. More importantly, the eight hexagrams from the diagonal of the 8 x 8 hexagram table were erroneously taken as the Yi Jing Ba Zi or eight trigrams. This was a misunderstanding for the Book of Yi Jing and it adversely affected the progress of human civilizations.

The five Chinese pinyin or English letters of “nN, iI, yY, eE, jJ” sound like the Chinese character 易 Yi, the title the book. These letters may indicate the earth’s evolution steps as described in the Book of Genesis of the Holy Bible (Genesis 1611): (nN) darkness like the night; (iI) sun (day – big moving sun), moon, stable and permanent island; (yY) river fork, water pool, lake, vegetation, fishing, biped humans in upside down position; (eE) sea or ocean bay, the Garden of Eden with fruit trees; (jJ) human migration and settlement.

譜 Pu is a traditional Chinese character related to human life, earth science and underground space. It has dictionary meanings of “write, compose, poem, music, spectrum, genealogy, cookbook, etc.”. It is a spelling index to the related Chinese characters for “garden, grape, preserved fruit, jade, store, shop, bed, water fall, pool, poem, benevolence, service, assistance, etc.”. Its further sonic extensions are “bo” (cypress) and “bu” (cloth). Its left hand side **𠂔** looks like an opening at the bottom of layered rock-mass. The bottom opening could indicate a cave, excavation, dwelling, water canal, water spring well or population at the hill bottom. The short brush on top of the hill could indicate rain and snow. The right hand side consists of a common Chinese radical which represents the letters “Y, U, V, W” at the top; **𠂔** Ye (work, double Ya, wildness, etc.) in the middle; **𠂔** Bing (combination) above; and **日** Ri (sun) below. The letter “U” represents “Wu” (dark cloud, fog, sense, understand, matter, etc.). The right hand side as a whole indicates the work of cultivating sprouts, rice paddies and trees for food by using the sunlight and soil. Furthermore, the left hand side is pronounced as “Yan” and the right hand side is also pronounced as “Pu”. “Yan” is a spelling index to the related Chinese characters for “talk, eyes, proverb, smoke, goose, swallow, talented person, show, beauty, bright, tight, serious, test, cave, rock, salt, smoke, grind, evolve, continue, research, etc.”.

The right side “Pu” means common, ordinary, spread, etc. Therefore, the whole character **譜** Pu shown at the beginning of this paragraph represents good and beneficial choices and practices that would help avoid interpersonal misunderstanding and ensure lasting happiness for the human kind on the planet earth.

On the other hand, the Chinese character **脆** Cui suggests a warning. It has a dictionary meaning of “brittle” and consists of the left hand part “Yue” (moon) and the right hand part “Wei” (danger). Its character structure suggests “the moon in danger” and “Si Er” (think of disaster and death). If the earth’s forest, fresh water and clean air were to be depleted, the rocks on the moon could gradually dry up to become more brittle. The Chinese character “Yue” (moon) are related to many other Chinese words by sound, such as “Yue” (read, pleasing, jump over, high mountain, music, etc.) and “Yu” (rain, fish, tree, maize, taro, feather, lodging, bath, nurture, happy, education, language, surplus, reputation, universe, forecast, jail, etc). Human daily work such as the washing of clothes and bed lining in rivers or streams and the drying in sunshine would help maintain healthy ecosystems.

The Chinese character **青** (Qing) has meanings of “blue-green” color. Together with its structure and pronunciation, it would indicate human effort to cultivate blue-green forest mountains to support the moon and the sun. Another character **清** (Qing) has water added to it, which indicates clean and fresh water. The Chinese character for hydrogen is also spelled as Qing. The relevant photosynthesis will be discussed in more details in section 4.7. Another relevant Chinese character **精** (Jing) has “rice” added to it. It means “refinement” and “spirituality”.

誤 Wu is a Chinese character with dictionary meanings of “Error, Mistake, Misunderstanding and Unfortunate Delay, etc.”. The left hand side of the character is the same as for **譜** Pu. So, this Wu serves as a counterpart of Pu for comparison. Its right hand side shows an opening above the sky or heaven. Such an opening could indicate pouring rain, strong sunshine, holes in the roof of a dwelling, and population, dwelling or excavation located at the top of hills, mountains or in the sky and space. It indicates incorrect choices and practices.

This character Wu can also be used to illustrate good and back practices in mining engineering. Mining is the most basic industry that has made agriculture

and other industries possible. It is best to locate the entrance tunnels of a mine at the bottom of the hill or mountain which hosts the mineral deposit. The excavated rocks and minerals as well as ground water could flow down to the lower entrance level by gravity. Natural ventilation system can be used to save energy cost. On the other hand, if the mine entrance shafts are located at the top of the hill or mountain which hosts the mineral deposit, then rain water would seep into the mine easily, and the water would have to be pumped up from the bottom of the shaft. Sinking the shaft would be more expensive and less safe than driving a horizontal tunnel. Personnel and materials would have to be hoisted up and down the mine with a cage or elevator daily. Electrical or other types of power would have to be used to hoist the excavated rocks and minerals. Workers inside the mine would feel less safe because they would have to climb up in emergency situations. Since the workers usually live in the valley, they would have to first climb up the hill and then descend down the shaft. Similarly to the above comparisons, large-scale open pit mining with heavy equipment to excavate a large volume of waste rock in order to extract a relatively narrow mineral or rock deposit is an incorrect practice. Not only precious machines, electrical or fuel power as well as explosives are used to break and remove the waste rock but valuable human and land resources are lost.

The practice of removing hills and mountain to build high buildings that would be useless without artificial cool air conditioning or heating is of course a serious mistake. Such a building requires a lot of steel and concrete that can only be made at the cost of human and natural resources and serious pollution to nature. Cool air conditioning is achieved at the expense of the open air and with electrical power. If not converted into electricity, the natural energy would otherwise go into the life sustaining wind, cloud and rain cycles. The precious electricity can be used for really important purposes. Similarly, removing hills and mountains to fill valleys to make large flat grounds is also a damage to nature in the long term because precious resources are used to make the change, but the end result would a loss of water, gravitational energy and other potential resources.

4.6 *Earth Science in English Words*

The English letters “A” and “H” represent in shape the human practice of fetching and shouldering two firewood columns with a bamboo pole from the shaded (“N”) high hills or mountains. The rotated

form “Z” for “H” represents in shape the zigzag road in the hills and mountains. Trees and leaves provide the best shade, wind barrier, temporary rain shelter, clean and renewable energy resources, construction materials, paper products and soil ingredients. Tree roots can break up rock and mix with it to make better soil. Trees store water and keep the air, water and soil clean. Trees also provide fruits, nuts and other types of food. Trees can help the otherwise barren sand and rocks to become productive land.

The English word “Mining” represents the Chinese words “Mi Min In Ning” (rice-grains-dense-etc., people-enlightenment-life-name-etc., cloud-forest-tree-shade-etc., peace-no worries-tranquility-quiet-calm-etc.). The English word “MinE” likely came from the 36th Hexagram “Min Yi” of Yi Jing (2852 B.C.). The related English words are “mineral”, “mind” “minute”, “mince”, “mint”, “miniature”, “minimize”, “ministry” and “minority”. Mining provided tools for agriculture, medicine, hunting, fishing, home construction, transportation, etc.. Mining also provided one of the best training opportunities for people as indicated by the Chinese characters “Chui Lian” or “Duan Lian” (hammering) and the English word “train”. Travel by walking and working for the trains are examples of other training opportunities. Agriculture should provide cultural education opportunities.

On the other hand, the English pronunciation of “mining” as “Mai Ning” means in Chinese pinyin “wheat-maize-buy-sell peace-no worries-tranquility-quiet-calm-etc.”. It was likely true that the wheat and maize crops and other dry land agriculture or animal husbandry on a large scale helped the drying up process of the earth, which helped the expansion and migration of the human population. However, this drying process has caused the existing land on high altitudes to become barren, certain land to become desert, and certain other land to be washed away into seas and oceans due to global warming, rapid river flow, tidal wave actions on the coast and wind actions on the mountains. Such consequences are contrary to the most important meanings for the Chinese characters “Min Yi”, that is, “to understand Yi.” or “the enlightened Doctor”.

4.7 *Interactions of Sunshine with the Earth*

The two Chinese characters **馨光** (Xing Guang) from the sentence **祖有馨光远** (Zu You Xing Guang Yuan) are found in the Yi Shi Zu Pu - Zong Ci of MaiYuanTou (1279). “Xing Guang” not only indicate the importance of sound, natural fragrance,

scent (pollen particles, gas molecules or other fine particles) and light as well as seasonal, cyclic and repetitive changes, but also the knowledge that light, sound, and fragrance and scent are a combination of wave propagation and particle movements. A person may see the light, hear the sound, and then smell the scent or feel the energy of an event or matter in time sequence. The sentence also indicates that ancestors went to far away places or came from far away places, may be as far as a distant planet; and they were enlightened in the mind.

The unified theory for light as electromagnetic waves and photon particles was likely mathematically formulated and verified in laboratory experiments in the 20th century (Einstein 1921). While light behaves more as waves than particles, fragrance and scent behave more as particles than waves. While these meanings are contained in the above sentence, the sentence gave an implication that the ancestors went to or came from far away places, may be as far as a distant planet. This would imply that human beings are not merely a result of the evolution of the earth nature. The current state of the whole earth has resulted from the interactions of human beings and Nature.

The wave phenomenon at an ocean beach could give a false impression that the water particles come with the waves from far away. Although tidal waves travel in shallow water at the speed of somewhat less than 200 m/s, the movement of a small freely floating object would indicate that the water particles move much slower. The plants, living organisms and fish, rock and sand that are below or above the water surface on ocean beaches affect the water quality at the beaches as well as the quality of air and rain on a far away land because tidal waves create water bubbles that become fog and cloud in wind and sunlight. Much like the tidal waves, light particles from the sun should travel at a speed that is much less than the light wave speed. The light waves are electromagnetic waves and photon particles that could energize certain local matter in air or on dry and sandy land to emit secondary heat or light. The two Chinese characters are also related to many other characters with same or similar pronunciation and components structure.

So far, scientists have not determined the true nature of gravity (Hawking 2002). It may be invisible subatomic forces and it might also form part of the visible light spectrum. The author observed in the grape fields of California that little tornadoes form continuously under the sun and carry dust into the sky. But, they terminated on the hill with grass and trees.

Such dust tornado does not occur in the rice paddies because they are either wet mud or covered with water. It has been reported that large tornadoes occasionally lift up a cow into air in the south middle part of the United States. The soil that large tornadoes carry into sky may eventually end up in the ocean to make it salty. If there were no forest mountains to protect the vegetation and creatures on earth from the otherwise fierce wind and if there is no water to keep the earth as an entity, gravity alone would not be sufficient to keep rocks from disintegrating or escaping into space. Atmospheric pressure and cool temperature are the two important factors to preserve water in the valleys of the earth.

4.7.1 Sunlight as Photon Particles

The sunlight may be considered as “photon particles” that impact on different types of matters of the earth such as rocks, soil, water, plants, organisms and living creatures. A photon may be considered as a visible subatomic particle or a gathering of particles like neutrons. The dust and air molecules in the atmosphere contain atoms and electrons. The mass of a photon should be similar to that of a neutron in the order of magnitude. The largest photon of a group of neutrons may weigh as heavy as the lightest hydrogen atom. The intensity or luminance of light decreases from the sun to the earth as a function of the inverse square of the propagation distance. The intensity or luminance of light can also be viewed as the number of photon per unit surface area perpendicular to the direction of light. The gravitational attractive force between two space bodies also follows the inverse square law

A simplified qualitative analysis for a photon particle impacting on the earth surface is performed here. Assuming that a photon particle has a mass of “ m ”, and a peak particle velocity or velocity amplitude of “ v_c ” immediately before its impact on the earth.

According to the Newton’s second law of motion, the impact force “ F ” is expressed as:

$$F = m (dv / dt) \quad (4.1)$$

Where v is an undetermined function of time t , “ dv/dt ” is the transient deceleration, that is, velocity change “ dv ” over the infinitesimal time span “ dt ”. If a particle of velocity “ v_c ” impacts on a completely reflective and elastic surface (a hard smooth surface such as a mirror) at the right angle, the photon particle retains the same velocity magnitude but travels backwards after the elastic impact. According to the theory of elasticity, the velocity changes from posi-

tive to zero and then from zero to negative. At the moment the velocity drops to zero at half the time duration of the impact, t_e , the elastic impact force reaches its maximum. The duration of the elastic impact, $2t_e$, is an undetermined infinitesimal quantity. The maximum impact force on the completely reflective surface is approximately:

$$F_e = m v_c / t_e \quad (4.2a)$$

The energy of the particle remains unchanged after the elastic impact, that is, the particle would rebound completely. A more elaborate mathematical analysis could be performed, such as assuming a sine wave function for the velocity “ $v(t)$ ” to obtain the variable force “ $F(t)$ ” during the impact time duration “ $2t_e$ ”. During an elastic impact, the net force for the impact time duration “ $2t_e$ ” is zero.

The elastic impact is a type of “Net Zero Force” dynamic phenomenon. It is often different from “Nothing or Nil”. On a large scale, it may cause the surface to vibrate a little. This explains the tornado phenomenon on dry and dusty ground. The mirror is an example of how a smooth glass surface can combine with a silver reflective coating to act as a perfectly reflective surface. One can study one’s own mirror image under the sunshine or lamp light to find out how photon particles work to make an visual image in the eyes and the mind. The mirror imaging process is as follows:

Photons from a light source impact on the human body such as a point on the black hair. Following the traditional theory in physics, the black color photons are reflected on the black color hair (other color photons are absorbed). This point on the hair may be viewed as a source of black light for the current analysis. Some of the black photons travel to the mirror and get reflected again, according to the physical laws of reflection and refraction, to reach the eyes to produce a black color signal for the point on the black hair. The human brain works to synthesize all the signals for all the points on the human body to make a human picture. The picture may get stored in the brain as a memory. The fact that color leaves and clothes would lose their color if dried up in the sunshine would suggest that photons can get stained to a certain degree with the colors of the matter under impact.

However, for materials other than a reflective mirror, some of the energy of the photon is usually lost. For example, the impact could cause the electrons of the material to energise to a higher temperature (such as

bricks in the sunshine). The photon particle itself could break up into smaller particles and bounce around until all of its energy is released. In analogy to the laws for nuclear fission or fusion, the disintegration or coalescence of photons may release heat.

On the other hand, if the particle of velocity “ v_c ” impacts on a completely absorbing or yielding surface (such as a plant leaf), the particle velocity becomes zero after the impact, that is, there would be no rebound. The velocity change with the impact is, $dv = v_c$. The time duration of the impact, t_y , is an undetermined quantity. The dynamic energy of the particle is completely absorbed by the impact surface and matter. The impact force is a function of time and its average magnitude during the impact is:

$$F_y = m v_c / t_y = m v_c / (k t_e) \quad (4.2b)$$

Where k is the impact time duration ratio of t_y and t_e . For, $k = 10$ to 100 , equations (4.2a) and (4.2b) give: $F_e = (10 \text{ to } 100) F_y$. Therefore, a single photon impacting on a completely reflective elastic surface, such as a sand surface in a desert, would exert a vibration force whose amplitude would be 10 to 100 times as much as the steady force for a completely absorbing or yielding plant leaf. This theory shows that a hard rock planet like the Mars or the earth’s moon would not absorb as much sunlight energy as the green planet earth. This explains why the moon – earth pair has endured the test of times. A visible macroscopic analogy of yielding is demonstrated in the yielding steel clamp on a steel rod under impact loading (Yi 1993 and Yi and Kaiser 1994).

An illustrative comparison for the above elastic and yielding cases could be to drop a table tennis ball on a concrete ground and on a rice paddy or dense bush tree. With completely absorbing plant leaves in the presence of air, water and minerals, the transformation of light energy into useful matter takes place in the photosynthesis. The light absorbing capability should increase from sand in the desert, green grassland or wheat field, rippling water with water plants under the water surface, rice paddies to a deep forest. The light absorbing capability is also a function of the color and smoothness of the material surface and the frequency of light.

For a surface with intermediate light absorbing capability, such as wet soil and still water surface, or if the light is at angle to the surface, the sunshine’s dynamic energy should exert a force on the earth besides rebound, heat generation, evaporation, photosynthesis, or other physical or chemical changes. As

demonstrated in the mirror imaging example, the color spectrum of light as displayed in a rainbow is not necessarily directly attributed to the sun. Part of it is a result of the impact and rebound of photons on the earth's surface and in the atmosphere. In other words, photons may get stained with color and subatomic substance during their impacts with different matters on earth.

A visible macroscopic analogy of intermediate yielding is the accumulation of plastic strains in a steel rod under repeated impacts, each exceeding the yield point of steel (Yi 1993 and Yi and Kaiser 1994). The salt water in the ocean would store a portion of the sunshine energy with a temperature increase because it is less easy to evaporate than the fresh water in a forest, river and lake. Hence, on the planetary scale, the sunshine would provide a steady pushing force to a deep forest but a vibration force to a desert or a salty ocean. This explains why tornadoes form in deserts and warm ocean water and why the moon's orbit around the earth is elliptical rather than circular. Such pushing forces would partially balance the invisible attractive gravitational forces that keep planets orbiting in circular or elliptical orbits around the sun.

Although the monthly cycles of ocean tidal waves and wind are mainly caused by the positions of the moon and the sun in the sky, the transient low amplitude and high frequency rider waves that a person observes on the beach, i.e., the ripples, are likely attributed to the sunlight impacts on the water. The higher the salt content, the slower it is to absorb the sunlight energy. This results in lower frequency but higher amplitude for the transient tidal rider waves. The human heart beat of about 60 pulses per minute or about once per second was likely a result of the sea or ocean ripple wave frequency in the ancient past of the earth. At that time, most of the earth was covered with water except for the Himalayas. The water was fresh and ocean organisms flourished. Today, the ripple frequency at the Pacific coast of Santa Monica, Los Angeles city is about once per 10 to 20 seconds, that is, 10 to 20 times slower.

4.7.2 Wave and Energy Properties of Sunshine

In the terminology of wave theory, the peak particle velocity, v_c , is more accurately defined as the "average peak particle velocity for an array of photon particles on a unit surface area perpendicular to the direction of light". It is an alternative representation of the intensity or luminance of light on earth. The light peak particle velocity should decrease as an inverse square function of the distance from the sun. It is

further reduced in the earth's atmosphere due to friction and absorption of the cloud. Therefore, it can have a minimum value of zero on the earth's surface on a rainy day. Its maximum value could be the speed of light in vacuum. A human would never get sunburn if the earth is covered with cloud all the time.

Generally speaking, the total energy of a matter is a combination of internal, kinetic and potential energy. The potential energy is a function of the height above a reference point. The total energy may not be a fixed quantity. The following Einstein's energy equation is a measure of the maximum energy of matter in the solar system:

$$E = M c^2 \quad (4.4)$$

where " M " is the mass and " c " the speed of light in vacuum, i.e., approximately, 300, 000, 000 m/s. The above equation assumes that the matter is completely transformed into energy in the sun, half of which is in the form of kinetic energy of light and the other half in the form of heat. The above equation implies that if a certain matter such as hydrogen can result from photosynthesis of plants (section 4.6) and if it is transformed into light energy, then the sun will shine forever and the earth can be kept warm. However, this equation can be misleading in human philosophy on the comfortable earth because it does not contain the potential and internal energy terms of matter. In the terminology of wave theory, the light wave should create a light pressure or stress whose magnitude is directly proportional to the density of the medium bearing the wave " ρ ", the wave speed in the medium " c_p " and the peak particle velocity " v_c ":

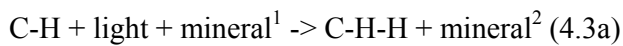
$$\sigma = \rho c_p v_c \quad (4.5)$$

The above pressure or stress is a representation of part of the pushing forces to prevent the planets from falling into the sun.

It should be mentioned that electricity can be generated from the nuclear energy of certain radioactive minerals on earth. But, the amount of energy is well short of that expressed in equation (4.4). More energy and materials are required to obtain the nuclear fuels and turn them into electrical power. The harmful radioactivity of nuclear waste is a million times more than that of the nuclear fuel material. The sunshine is a kind of nuclear power that can be harnessed for a series of recyclable uses and it will last for eternity.

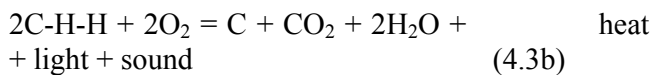
4.7.3 Transformation of Energy and Matter

Suppose a green leaf contains mainly carbon and hydrogen atoms and water molecules. The impacts of photons would mean the absorption of numerous neutrons to form hydrogen atoms as well as the transformation of hydrogen atoms into carbon atoms. Hydrogen is a light element whereas carbon is a stable element. This is the essence of photosynthesis. Generally, any photosynthesis process can turn sunshine into matter. Specifically, the photosynthesis of plants uses carbon hydrogen compound, sunlight, water, carbon dioxide, nitrogen compound and other minerals in air, water and soil to make carbon hydrogen compound, fiber, sugar, oxygen, etc.. Such process on a large scale may even generate fresh water. The simplest photosynthesis of light into matter transformation is illustrated as follows:

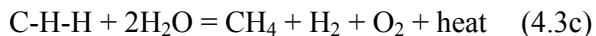


The above is a kind of slow nuclear reaction. The minerals can be organic or inorganic. Such photosynthesis may also occur for live organisms.

The slow burning of wood in low temperature conditions to produce heat, light and sound is a simple example of the reverse transformation of matter into energy. It is illustrated as follows:



The following is the simplest example of the slow decay of green plant leaves in confined conditions to produce combustible gases:



The hydrogen gas is very thin and light and may find its way through cracks into the atmosphere, where it could possibly ignite to produce light.

Equations (4.3a), (4.3b) or (4.3c) demonstrate a cyclic or circular process of change, that is, “Yi” or “Zhou Yi” in Chinese (Baynes 1950).

The summation and accumulation of the infinitesimal forces from photon impacts or the conversion of energy into matter over half of the global earth surface and in endless time period can reach great proportions. Observational, mathematical and computational proofs for such effects can be seen from the strength of a bundle of hairs, the edible oil extraction from oil camellia seeds with repeated human impacts with a wooden log (DongAn 1970's), the information stored in bits of “0” and “1” on a computer, elastic stress wave superposition in the impact testing of steel rods (Yi 1993 and Yi and Kaiser

1993), the Boundary Element Method in geomechanics (Crouch and Starfield 1983, EXAMINE2D 1989, MAP3D 1997), and mining induced stresses in underground mines (Sprott et al. 1998, Doran et al., LeBlanc et al. 1999 and Yi 2003). In the second example, the left over camellia seed cakes became like a soft rock after being dried up.

70% of the earth's surface is covered with ocean water whose reaction with a photon may stand somewhere between perfectly reflective and perfectly absorbing surfaces. The sunlight's impact forces and energy transformations on the oceans and the continents of forest, snow or rocks are different. This contributes in part to the earth's self rotation as well as ocean tidal waves and the ecological cycles of evaporation, cloud, wind, rain and water flow for the growth of all living things.

The actions of tidal waves and wind on shorelines and hills on the west coasts of continents may also be analysed in terms of water particles' impacts on rock slopes or cliffs and their reflections. The steeper the slope and the harder the rock, the greater the impact forces would be. A sloped ocean shore would ensure that the earth rotates at a constant velocity and travels at a constant speed around the sun. Acceleration or deceleration would cause earthquakes and volcanoes.

4.8 *Natural Changes on Earth*

The Planet Finder software makes it possible for everyone to study the sky and weather changes at any moment in time. It could be suggested that the earth's rotation towards the east around its south-north axis contributes in part to the eastward tidal movement of the salt water in the Pacific Ocean. The combined light, gravity and heat energies from the moon, sun and other extraterrestrial energy sources also contribute to such tidal movement. The ocean tidal waves and wind have pushed the west coast of America eastward to cause seismic events and earthquakes. Loading of rock mass by tidal waves and by water pressure may vary between servo-controlled and uncontrolled dead load. Water also causes the softening of soft rocks. Due to the larger body of water in the southern hemisphere, there is differential widening of the southern Pacific Ocean, which causes the north end of the Pacific Ocean, the Bering strait, to open further into the Arctic ocean. There exists a tension boundary at the bottom of the mid Pacific Ocean, where there has been earthquake and volcano activities (Goter 1979). The South American continent has moved towards the east into the Atlantic ocean, which is the cause

for increased volcano and earthquake activities in Mexico and Central America (Reilly and Jermyn 1990). The west coast of Australia and south east Asia in the Indian Ocean has been subject to similar tidal waves as the west coast of America.

The sunlight, tidal waves, wind, land, forests and forested mountains are the direct causes of life supporting cycles of wind, cloud, rain, fresh water and river flows (Smil 1997). Fig. A-3 shows that the thick fog blown over from the Pacific ocean at sunset followed the slope of the eastern side of the Mount Tamalpais as if the forested hill was pulling the fog down after a day of drying in the strong sunshine. With a car, a person could observe how water dews flow from the inside surface of the front windshield glass to the rear view window glass following the direction of the sunshine. One could occasionally observe that in the cloudy sky at about midday time when the sun is above the cloud, tails of cloud descend from the dark sky. Such phenomenon can be explained by the particle and wave theory of light (sections 4.7 and 4.8). It must be cautioned that water evaporation in the ocean is most difficult due to the salt solution and the mixing effects of the tidal waves. The water evaporations from water plants, trees, ponds, rivers and cascading river pools are easier and fresher.

There are limestone and other sedimentary rocks containing fossils of water plants and organisms on the high plateaus of the earth, such as in the Yunnan province of China. There are also salt lakes such as the Great Salt Lake of Utah state of United States and the QingHai Lake of Qinghai province of China. There are sandy domes or river sand beds on dry hills such as the hills of San Francisco and the Chino State Park in Los Angeles county, California. These geological evidences would suggest that there was much more glacier, permafrost land and clean water on earth in the past than it is today. The cultural evidence is that the people in DongAn county, Hunan province of China continue to call rocks "Horse Bones". Such fossil based rocks were formed in the clean water of seas and oceans whose freshness should exceed the water of the Great Lakes on the border of Canada and the United States at the present time. The lake water is not only left over from earlier fresh water but also purified by trees in the water to rain cycles.

Although part of the Himalayas might have risen from the core of the earth as molten rocks, certain other lands might have formed in the evolution of the earth as floating islands made of extraterrestrial meteorites, earthly ice, dead plants and sea life, sand

deposits at ancient river mouths, and volcano ash. One could make an analogy between the crack patterns and rivers. Bifurcations are common. Many small tributaries are often found in the upstream area, but the main river close to the ocean is deep and predominant. The river mouth on the coastline is subject to change due to tidal waves and ocean plants and organisms. The pattern of a river system depends on the regional rock type, structure and stress field.

4.9 The Earth's Role in the Solar System

The earth is firstly subject to west to east self-rotation around its north-south axis, secondly, the gravitational pulling of the moon, thirdly, the gravitational force of the sun and other planets of the solar system, and fourthly, the possible slight pulling force in the northern direction from outside the solar system by stars such as the 7-star Big Dipper (North- Polaris Star) and other unknown stars. The earth's self-rotational energy comes likely from both the earth itself and the sun. The earth's orbital motion around the sun has likely been maintained by earth's self-rotation energy and, possibly, the sun's self-rotation around its axis normal to the plane of the solar system (Fig. 12). It is likely that the entire solar system revolves around a certain star or stars forma.

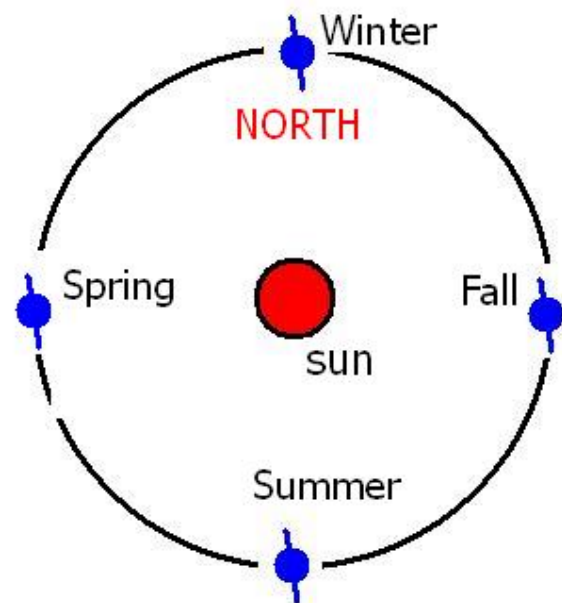


Figure 12. A graphic illustration of the earth's orbital travel around the sun as well as seasonal changes in the northern hemisphere of the earth. Notice that the earth's self rotation axis has constant tilt angles both in and out of the solar system plane.

tion such as the above 7-star Big Dipper.

The earth's constant-angle self-rotation axis causes yearly seasonal changes on earth (Milton 1977). It is likely related to the specific north and south poles land structure that forms a ring-shaped shorelines of the Arctic ocean (Fig. A-2a), and the Antarctic mountains (Fig. A-2b) (Carr 1998). It is likely maintained by the earth's tidal and wind forces on ocean shorelines as well as the above fourth force. The earth's constant-angle self-rotation axis provides for the earth's electromagnetic field. Its existence has not only made possible the accurate predictions for future days, seasons and years possible, but also the memory of the earth and of the human brain.

As a result of the above forces, certain continents of the earth such as America displaces slightly towards the north as well as the east. This would be analogous to what happens in a mineral processing machine, the hydro-cyclone, in which heavy matter gradually sinks by gravity in a spiral path. Such gradual northeast infinitesimal displacement explains the regional in situ stress orientations in Canada or Sweden, that is, the major principal stress direction is in the first quadrant from north to east (Hudson et al. 1993 and Yi 2003). The build up of stresses is attributed to the accumulation of tidal wave and wind effects on the rock mass, the exposure of higher land from the ocean as well as the increase of specific density of the sea and ocean water. The sudden change in the earth's self rotation velocity can also be a contributing factor. The fact that the mountain ridges and river valleys in North America are orientated approximately in the north-south direction would suggest that America was mostly affected by the current earth self-rotation mode. The major principal stress in western USA is perpendicular to the coastline of California (Hudson et al. 1993). The very high in situ stresses deep in earth that has gradually accumulated in time have likely contributed to the formation and concentration of certain energy and mineral resources such as oil, coal, natural gas and mineral deposits. Such resources were also formed on deep sea and ocean bottom or in rocks near sea and oceans where there is more water to provide the high hydrostatic pressure. Different kinds of rocks are formed in certain areas of the earth's crust where sand, fossil, gravel and mud are mixed with oil and gas in high temperature and confined conditions, particularly near deep ocean bottom. Volcano eruption is an extreme manifestation of the rock and mineral formation process that may be called "natural metallurgy". One additional effect by modern oil wells is the drying up of air and water from certain parts of the earth. The tidal wave and wind actions are partly both the cause

and the effects of the earth's self-rotation at different times in lunar monthly cycles.

If the earth were to be compared to a person, the ocean tidal waves would be like the heart beats; the ocean shores on the west coast of continents like the legs and feet; the rivers and streams like the blood veins and the nerve system; the sunlight and the rain like the food and drink; the plants, rivers, fish, animals, seas and oceans, and the global electromagnetic field like the digestive, sensory, memory and the brain systems. Because the earth is the only planet that has large quantities of water in the solar system, it is likely the only planet that has the liquid kinetic energy to compensate for any unusual energy loss or gain along its elliptical orbit around the sun. The English word "Spring" represents the season of sprout, accelerated plant growth and quick rise of water. The word "Fall (Autumn)" the season of leaves falling off certain trees. The Spring season turned to be the season in the northern hemisphere when the earth is "pedaled up" by tidal waves and wind forces toward the south of the solar system, and the Fall season turned out to be the season of its "falling down" to the north of the solar system due to gravitational pull of stars such as the 7-star Big Dipper (North-Polaris Star) or other unknown stars, located somewhere in the North-West quadrant of the solar system plane (Fig. 12). Observation of the 7-star Big Dipper in a yearly cycle with the Planet Finder software (Crowell 2003) would indicate that the earth's self-rotation axis is not only tilted in the solar system plane but also out of this plane. It is possible that this axis is deflected out of this plane when it is pointed to the sun at winter and summer times. Although the solar system has abundant gravitational energy to provide for the concentric, attractive or pulling forces, the earth's ocean tidal wave and wind forces in the tangential direction of the elliptical orbits are necessary to keep the planets, or at least the neighbouring Mars and Venus, in harmonious motion in case of unusual energy increase or decrease from the sun, or at the times of unbalanced planetary configurations. Due to the abundance of water that can change between the liquid, gas and solid states, the earth is like a "servo-regulator" for at least the neighbouring part of if not the entire solar system. This would remind the human kind on earth of more prudence and responsibility than so far realized.

It might be suggested that there was a larger Pacific ocean in the remote past under the earth's current eastward self-rotation mode. The long coastlines of Europe and Africa served as the "pedal of tidal

waves and wind". This created a tension zone at the middle bottom of the Pacific ocean. The continent of America eventually rose up as volcanoes islands. The islands were exposed as the ocean water level lowered. There might be an even earlier time when the earth rotated around an east-west axis and the southern steep slopes of the Himalayas in Nepal served as the "pedal of tidal waves". Tidal waves and wind likely contributed to the round shape of the earth as ocean water level lowered.

4.10 *Human Interactions with the Earth*

The expansion of human population, large-scale animal husbandry and dry land crops in the past likely prevented certain land from forestation. This likely contributed to the drying up or retreat of water and ice on earth. Tidal waves, wind, rivers and living organisms also contributed in part to the formation and modification of coastlines, mountains, hills and valleys. The increasing salt content in sea and ocean waters is attributed to rain water runoff on bare land, tornadoes carrying dust into oceans as well as increased dissolution of the soil and rocks that form the coastlines.

The cold winter weather in the north end of the earth is due to the shielding against the sunshine and wind by the middle and southern half part of the earth. Similarly, the northern half of the earth provides shield for the winter in the southern hemisphere. The middle part of the earth at the equator is exposed to sunshine all year round. Deforestation in this middle part would lead to the melting of the polar ice caps. Part of such unlocked water would eventually disappear into outer space in strong sunshine through the unshielded areas or holes of the earth's atmosphere, in analogy to volcanoes or tornadoes on certain parts of the earth. Tiny sand, metallic or chemical compound particles in the air or on desert sand may be ignited by sunshine to emit heat and light.

Likewise, the middle part of the earth relies on the cool wind from the south or north poles for cooling in the summer. The west coasts of continents are subject to strong tidal wave and wind actions. The advantage is water evaporation in the form of tidal wave bubbles from ocean shores. Increased salt content in seas and ocean increases heat storage and reduces evaporation, that is, weakened water to rain cycles. Global warming and air and water pollution together with tidal wave actions cause frozen land to thaw and soft rock to dissolve into the oceans as well as weather bifurcation. Therefore, large scale deforestation, intensive and continuous energy consumption, dry land agriculture, and chemical and

drug pollutions in either the warm middle part or the cool north or south part of the earth is gradually destructive to the natural earth in worsening cycles. The development of beach resorts as well as the intensive use of chemical fertilizer, pesticide and cleaning agents have caused the pollution of ecosystems and the reduction of plants and living organisms in the water. All these factors have rendered the earth's fossil energy replenishing process inefficient if not diminished.

Natural rice farming is a very good agricultural technology for warm weather conditions because it conserves water for the cloud and trees, transforms the sunshine to food and soil, permits the growth of living creatures in water and on land, and is naturally limited to river valleys. On the other hand, large-scale and intensive rice farming at the expense of forest can cause the warm water to be discharged into the ocean to add to global warming. Small scale dry land farming and animal husbandry with forest mountains and hills as the background are good for colder weather conditions. But, if they are done on a large scale, they are much worse than rice because the irreversible loss of fertile land will occur.

The flowing Norwegian sea in the north end of the Atlantic ocean and the Bering straight in the north end of the Pacific ocean were likely due to accumulated global warming, air and water pollution and tidal and wind actions that led to the thawing of ice, glacier and permafrost land. The Norwegian sea has become a weak link in the land ring structure around the Arctic ocean (Fig. A-2a). It allows the warmer Atlantic water to invade the Arctic ocean which would otherwise be frozen all year round.

One typical example for a lake to turn into desert is briefly described as follows:

Suppose there is a lake or water reservoir in a valley. If the trees on the hills around the reservoir are cleared out and the land is used to grow dry crops or grass, the opposing hills would reflect the sunshine onto each other as well as into the lake. This would lead to the "double or triple sun" phenomenon, i.e., the lake or the hill side is under the direct sunshine as well as the reflected sunlight from the slopes. A V-shaped valley would channel the sunshine into the bottom. If there is little rain in the region, and the water in the lake is discharged or used up for residential, agricultural or industrial purposes, the hills would gradually become bare. Soil would become dust that would go up into the sky in swirl wind or tornadoes, and a desert of loose sand would form. A narrow valley with the long axis in the north-south direction is particularly susceptible to the double sun phenomenon because the sun rises in the east and sets in the west. The death valley of California is an example. Sunlight reflections by glass windows, skyscraper buildings and concrete pavement also cause the double or triple sun phenomena. An analogy is that if a 110 volt electrical transformer is plugged into a 220 volt outlet, it would burn immediately. The strong sunshine can cause a blister on the

human face in minutes. A city could turn into a desert with time in a similar process.

Another example is to dig a straight river channel to replace a winding river. The immediate gain was some production land converted from the old river. But, human and material resources have been consumed to directly dig or use machines to excavate the new channel. The river's irrigation area, cascading pool water reserve, fish amount, water purification and home usage functions are all greatly reduced. From a practical point of view, a damage to the ecosystem such as above is very difficult to repair or reverse because the process was accompanied with human population increase or significant consumption of natural resources.

Another possible cause for global warming and weather bifurcation is air pollution and the possible earth's orbital decline towards the sun due to volcano eruptions, fire accidents in underground fuel storage and oil wells, explosions and blasting, and rocket and jet launches during the night according to the gas propulsion and dynamics principles. Such orbital decline may also result from the specific density increase of the global earth due to decreasing amount of ice and water, tall trees and mountains, the height of the atmosphere, and increasing ocean water density. Water, oil and minerals in deep obsolete underground tunnels of a few thousand meters in depth may be subject to extreme pressure from rocks or liquid, which may cause chemical or nuclear reactions at the bottom. With accumulated likelihood of accidents, the earth might even be propelled out of the solar system in the transverse direction perpendicular to the solar system plane.

4.11 *Interactions of the Sun, Moon and Earth*

While the sun and moon both contribute to the ocean tidal waves and wind, the moon's rotational energy comes mostly from the earth's self rotation energy. With this precondition, the sunlight from the sun may contribute to a certain extent to the moon's revolution around the earth (equations 2a and 2b). Since most marine plants and life exist on continental shelves and bay areas and the tidal wave forces act on the coastlines, it is clear that further reduction in the level or volume of ocean water as well as the fresh water content will not only reduce marine plants and wildlife but also the earth's self rotation velocity. The reduction of marine plants and wildlife has become a certainty in most parts of the earth because of human presence, industrial pollutions and insufficient rainfall. Without sufficient deposits of marine fossils, the stability of islands and continents

would be adversely affected. The consequence would be decreasing useful land area and natural resources for next generations. Fresh water and air, fossil energy as well as mineral resources would not be efficiently renewed and replenished. Due to global warming, pollution and weather bifurcation, the earth might have approached the point of irreversible damage.

Certain people may have misunderstanding about the relative importance of the moon and the sun to the planet earth. They appear about the same size to humans on earth and they unite and separate in the earth's sky in monthly cycles. The sun is the center of the solar system and it is much brighter than the moon. But it is far away from the earth. The moon provides differential gravitational attraction and moonlight pushing force on different parts of the earth at different times of the lunar cycle to contribute to the earthly wind and ocean tidal waves to help maintain the water to rain cycles. Sunlight is another energy source for the ocean tidal waves. Water evaporation on a smaller scale can also occur in still water, forest and rivers due to the sunshine and atmospheric pressure changes. The moon keeps the earth warm during the night so that plants, animals and humans can exist. The monthly cyclic weather changes on earth are attributed mainly to the moon, whereas the yearly seasonal changes on earth are attributed mainly to the earth's motion around the sun. A woman's menstrual period is directly related to the monthly lunar cycles. There would be no human race without either the sun or the moon, or if their apparent dimensions are too different. If the water to rain cycles of the earth continue to weaken and disappear, the moon might fall off to the earth or the sun, or it might get lost in space. To a certain extent, the equality of the moon and the sun is the astronomical basis for the equality of men and women and of different races.

The moon's connection to the earth can be seen from the total moon eclipse of January 10, 2001 in Bulgaria (Fig. 13) and of October 28, 2004 in San Francisco, which the author carefully observed for three hours in San Rafael. The connection may be in a form of gravity, light and electromagnetic interactions. The sun and the full moon were 11 hours apart across the sky and there was no cloud. The moon was in a light grey color and looked like a planar shape shortly after sunset prior to the eclipse. The eclipse started at 6:14 p.m. and totality began at 7:23 p.m.. The moon gradually turned into a light pink color in total eclipse that lasted for the next 82 minutes.



(a)



(b)

Figure 13. (a) Moon eclipse of Wednesday, January 10, 2001, 00:36 GMT. A multiple color image taken over Bulgaria in time steps from left to right. (Courtesy of BBC News website). (b) A totally eclipsed moon transits San Francisco's Transamerica Pyramid Wednesday for 82 minutes (Courtesy of San Francisco Chronicle Newspaper website-Photo by F. Larson).

During this time period, the moon hung in the sky above the bay water like a golden ball. The phenomenon of total moon eclipse occurs when the Earth passes between the sun and the moon. The pink color may indicate high temperature on the moon's surface. The surface likely emitted light according to different temperatures at different points. As a result, the moon looked much more spherical than usual. As the moon gradually emerged out of the shadow of the earth, it turned into a light white color circular shape in the dark sky. The moon is like a heavenly mirror reflecting the sunlight. Fig. 14 shows two views at the top of a cliff at the Glacier point in Yosemite National Park in the summer. In the top picture, a bare hard rock mass stood firmly in the wind across the valley. There was a short cypress tree close to the top of the cliff on this side of the Yosemite valley. The bottom picture shows a group of red fir trees on the edge of the cliff to the left side of the short cypress in the top picture. The cloud in the immediate distance generated thunder. One of the tall red fir trees in the picture was losing leaves and barks from the top down. This phenomenon was confirmed by another tree in the vicinity. The trees stood on a rocky mountain slope and the amount of



(a)



(b)

Figure 14. Color photographs at the Glacier Point on the mountains of Yosemite National Park in the early summer of year 2004. (a) Shows the Half Dome rock (used for rock climbing) in strong wind on the other side of the Yosemite valley and a dark cloud in the distance with lightening and thunder. The short cypress tree stood in the rocks near the cliff top on this side of the valley. (b) Shows a tall red fir trees, one of which lost leaves and barks at the top, possible due to disease.

soil available to them is limited. The tall trees are more susceptible to cold wind at the top and insect attacks from the roots. It has been occasionally found that an entire tree could fall down suddenly due to root or trunk failure in strong wind (Fig. A-4). On the other hand, the redwood trees in the valley below are big, tall and healthy. In California, certain Giant Sequoia trees are claimed to have lived 1450 years or more on the basis of ring count. They grow to a diameter of more than 3 m (AAA 1933) (wikipedia 2006). The author examined the display tree log in Los Angeles (AAA 1933) and found that each ring consists of a soft layer of about 3 mm thickness and a hard smooth layer of about 0.25 mm thickness. This ring structure is maintained from the inner most to the outer most layers. The ring count method is typically applicable for weather conditions with sharp contrast between the winter and spring of a year. At the present, the annual weather change in central California is mild but there is quite a contrast between day and night every day. The weather was definitely cooler 200 years ago. It would seem that the ring count method is accurate until a certain growth age. When the tree stops to grow annual rings, it may develop ring like structure simultaneously inside the existing rings of larger thickness. Therefore, the age for old trees may be

subject to overestimation by the ring count method. Nevertheless, a conservative estimate of a quarter of the 1450 years, that is 362 years, for the age of the redwood log above would still be outstanding. It is also found in Marin county of California that the redwood tree is an exceptional tree in that a ring of several trees will grow to merge into a single tree to the extent that a steel bar placed between two trees to separate them would eventually become an integral part of the tree. The exceptional trees in California could be attributed to the fog from tidal waves and maybe the higher salt content in the fog than other places in the world.

4.12 *Challenges and Hope for the Human Kind*

The humankind started small and feared wild animals at the beginning. The ancient book of Yi Jing indicated that humans created languages to effectively communicate with each other in order to defeat the beasts. Animals were over run because they lacked the language ability and did not develop the ability to make powerful tools. Some humans multiplied in numbers quickly and some became organized into large organizations, companies and governments. Some made powerful tools and machines. The human bases expanded from river valleys, mountains, to sea and ocean shores. Although organizations and machines have contributed to a certain extent to the human independence, sufficiency and power, the gains have been more than offset by the degradation to the earth Nature. Some organized persons have become too powerful to overwhelm Nature. At the present time, the human kind continues to race towards the exploitation of the earth and of other humans for the self-destruction and collective suicide. One sad example is that certain humans do not use language to effectively communicate for the common good but to confuse and cheat others into trouble. Certain groups of persons would work to cultivate criminals and certain other groups of persons would work to use them to make a living. Precious natural resources are consumed and wastes and pollutants are accumulated at alarming rates. Many persons are highly specialized in a fine discipline of knowledge and labor but lacked the overall understanding of the life sustaining earth nature. Some of them used people's money to create certain knowledge or things without giving back to the people. Many persons are homeless and have no place to sleep while 30% of the available apartments are available and much available office space and equipment stand idle. Manufactured goods are turned into garbage too quickly. Certain governments would pay generous salaries to teams of man-

agers and staffs in the name of helping the poor and the homeless people but they would not give one tenth of the salary directly to the persons in need. A large portion of the industries of the world are in indirect or direct preparation for defense and wars, and some of the rest are for temporary pleasure or comfort without the regard for the long term benefit of self, community and the generations to come. Global warming and pollution, the conversion of agricultural land for industrial use or their transformation into desert, the large scale use of metallic machines to replace human intellectual and physical work, the rapid consumption and waste of hydroelectric, fossil fuel or nuclear power in industry, transportation, office and household is having the effect of preparing the earth for the occupation of robotic machines. A clear comparison of natural versus machinery powers is made as follows:

Food or wood material can be cultivated with natural rainwater on a certain land. If the rain disappears due to water and air pollution and exploitation of the earth, then river dams and a complex irrigation system would have to be constructed to get water for the land with the powers of human beings, organizations, machines and fossil or nuclear energy. The land would eventually turn into a desert.

The Holy Bible recorded 60 generations of family lineage from Eve Adam to Jesus Christ. These 60 generations coincide with the first 60 hexagrams of the book of Yi Jing from "Qian" to "Jie". Birth and life span data are available only for the 24 generations (3 x 8 or tribal) from Eve Adam to Joseph of Egypt (son of Jacob/Israel). The first generation Eve Adam and the tenth generation Noah lived 900 years of happy longevity during the time of about 5000 years ago (Genesis 1611). They likely accumulated tremendous knowledge, wisdom, healthy practices, yet consumed very little resources. There was likely abundant food and energy in the vicinity and there was no need for hard physical labor. The air and water were clean. The humankind exists today partly because of their wisdom and effort. The life span gradually decreased to 147 and 110 years for Jacob (Israel) and Joseph respectively about 3500 years ago. Population expansion and decreasing natural resources in the vicinity of dwelling were likely the main causes. These biblical records were likely translated from the earliest editions of the Yi Shi Zu Pu, which unfortunately got lost in China. The biblical names Eve, Adam and God could be related to Yi Ling Gong, the ancestor of the Yi nations in China (Yi Shi Zu Pu 1930). Calculation shows that one couple can expand to today's world population

of about six billion in about 3000 years if they lived 70 years on average and three children were born in each generation. It should be noted that the long life expectancy of 900 years as written in the bible could not be verified from the available Yi Shi Zu Pu. A conservative estimate of a quarter of the 900 years to account for the possible error of taking a season for a year, that is, 225 years of life span for Eve Adam, is highly believable. The author of Genesis likely calculated the life spans for the generation by extrapolation between the erroneous 900 and the real 110 years. However, the Chinese idiom “A Person Over The Age Of 70 Is Joyful Since Ancient Times” was written erroneously as “It is rare for a person to live over the age of 70 since ancient times”.

The persons at that ancient time likely worked for the “Yi”, “Shi”, “Zu”, and “Pu” in the Chinese language, which partially translate by pronunciation into, “natural environment for eternal happiness, clothing, reading and walking”, “food, knowledge, excrement and garbage recycling”, “trees, house dwelling and ancestral heritage”, and “bed, bathing pool and garden”, etc.. Time, space, air, water, energy, and other resources were free. Wooden machines were used to extend human power. Time, as we know and feel it today, was likely flexible. Here is an example. A person could stand on a threshing ground in the hot sunshine of August and count the passing of time in minutes. Then, the person could walk to a water streamside, sit under a big tree, eat a cluster of grapes from the vines on the tree, do angle fishing and enjoy the breeze. As late as 400 years ago, intellectuals like Isaac Newton (1642-1727) acquired knowledge and worked in many disciplines from religion, philosophy, mathematics, physics, alchemy, economics, to gardening (Wikipedia 2006). A philosopher used to be a learned person who has all the knowledge about the world.

The average life expectancy at the present time is much less than it was 3500 years ago and it is getting worse. More and more people suffer from sickness, accidents, crimes, disasters, or miserable short life span. These should be sufficient reasons that we must make positive changes for the better. The humankind’s understanding of nature, population growth, health, individual and organizational behavior has accumulated. The recorded human knowledge and experience throughout history should help every human to foresee the possibilities and limits and realize the full potential in the future. Hope exists for every person on the earth to live and work peacefully, follow reasons, observe the laws of Na-

ture, achieve lasting happiness, and conserve and cultivate the earth for eternity.

4.13 *Summary of Discussion*

The following points give an idea of what was discussed in this section. Readers should read the details.

[1] The complete load versus crack opening displacement was obtained in the servo-controlled laboratory testing. The recorded curve looks like a hill with up and down slopes. More acoustic emission was measured with harder and tougher rocks. If it were not for the servo-control, the downward slope and the post-peak acoustic emission signals would not have been recorded.

[2] High stresses in the earth’s crust can cause the failure of underground reserves of oil and other organic reserves as well as rocks. Tidal wave and wind actions on the west coasts of continents can gradually erode away soil and soft rocks on the coast and cause dynamic and cumulative stresses in the earth’s crust, earthquakes, volcanoes, and the damage of ground or underground works. The underground extraction of water, oil, gas and other organic matter will deprive the earth’s ability to store heat and damage its capacity to maintain comfortable and steady weather conditions.

[3] The weather and tide in California are strongly affected by the positions of the Moon and the Sun in the sky on lunar monthly cycles. Weather changes caused the occurrence of earthquakes and rockbursts in California and Ontario, Canada.

[4] Human ancestors have interacted the earth nature and encoded their knowledge and practices concisely in the Chinese characters and other languages. For example, the concept of fragrance, sound and light as waves and particles was encoded in the Chinese character “Xing”.

[5] The ancient book of Yi Jing (I Ching) – Zhou Yi was the origin for both Chinese character, pinyin and western alphabet languages. It likely provided the prototype for human civilizations. However, the recent English translation of the book contained misunderstanding of the original texts. This has adversely affected the progress of human beings.

[6] Formulas were derived to explain how sunshine interacts with the earth in terms of photon particle impacts on different types of matter on earth and in air. The sunshine is transformed into useful matter in the photosynthesis. Besides the traditional laws of light reflection and refraction, photons can get

stained with the color of the matter under impact. The photon particles' impact forces provide a pushing force against the invisible gravitational attraction forces to keep the earth in its orbit around the sun. Photosynthesis and the burning of wood or carbon demonstrate a complete cycle of the transformation of energy to useful matter and vice versa. The action of the sunshine on the green and blue planet earth partially contributes to tidal waves, wind, earth's self-rotation and the moon's rotation around the earth.

[7] Einstein's energy equation is applicable to the sun and certain microscopic processes involving very small particles such as photons and hydrogen atoms. On the comfortable earth and in philosophy, it is incomplete because potential (position) and internal energy terms of matter are not included in the formula.

[8] The earth as it is today is an intricate system in balance. It can be personified as a person with memory, sensory, comprehension and action systems. The most important aspects of the system are: the yearly seasonal changes as the earth orbits the sun; the monthly reunion and separation of the moon and the sun in the earth's sky; the cycles of tidal waves, wind, cloud, rain and river flow; the area, volume and freshness of the oceans; the stability of the continents and islands with their forest mountains; the global electromagnetic field; the cold land ring structure at the north pole and the cold mountain at the south pole (critical for the earth's self-rotation). Large-scale deforestation, air and water pollution, and dry land agriculture and industry can cause damage to such balance. The moon and the sun are the astronomical basis for the equality of men and women and that of individual persons.

[9] The earth is the only planet in the solar system with an abundance of water that can transform among the three states of liquid, vapor and ice. It acts as a servo-regulator for at least the neighboring planets of the earth in the solar system to compensate for the sunshine changes and to overcome unbalanced planetary positions that may occur occasionally.

[10] The book of Genesis of the bible recorded that Eve Adam lived about five thousand years ago and that together with Noah, they lived 900 years of happy longevity. These names could be related to Yi Ling Gong, the ancestor of the Yi tribal nations in China. Calculation shows that one couple can expand to today's world population of about six billion in about three thousand years if they lived an aver-

age of seventy years and had three children in each generation.

5 CONCLUSIONS

The main conclusions are as follows:

(1) For Kallax gabbro, the fluorescent dye proved effective in tracing cracks and microcracks. A crack contained bifurcations, loops and a damage zone of connected micro-cracks. The fracture process zone was about 10 mm length. Crack propagation in the Bjorka marble was more straight forward, and the fracture process zone was likely small. But, the fluorescent dye permeated into the grain boundaries and the grains themselves.

(2) The fracture toughness of Kallax gabbro is more than twice that of Bjorka marble. The fracture toughness and acoustic emission count rate of hard rock is somewhat proportional to Young's modulus, but quite independent of density. This parameter for the Kallax gabbro is about 10 times that of Bjorka marble. Its maximum value occurred in the post peak load regime, more so for Kallax gabbro than Bjorka marble. An earthquake or rockburst that occurs in a tough or hard rock mass should have more "after shocks" than in a relatively soft rock mass.

(3) The changing positions of the Sun and the Moon in the earth's sky have definitive correlations with the weather changes on earth in California such as tidal waves, wind, cloud, rain and river flow. The in situ rock stresses in the continents, tidal and wind actions and the earth's self-rotation are related to one another. Increasing water and air pollution, global warming, ocean tidal waves and wind actions have likely contributed to the loss of ice, glacier, water, fertile land area and certain land mass, but the increase of in situ rock stresses. Such increased stresses may have caused the fracture of rocks and increased seismic or volcano activities. The number of seismic events in a certain rock mass or structure per unit time period could help predict the occurrence of rockbursts and earthquakes to a certain extent. Comprehensive methods should be developed and employed to predict earthquake or rockburst occurrences, and to avoid and prevent their damage. The in situ rock stresses contribute in part to the formation of energy resources. Along with available energy resources in the earth, they contribute to the making of rocks and minerals in the earth. Hard rocks are essential for the stability of islands and continents. Natural materials should be used as

much as possible to reduce the use of human, energy and material resources in the making of artificial materials. Such resources as electrical power, if not generated, would otherwise be naturally recycled in the ecological cycles of the earth.

(4) Although the solar system has abundant gravitational and sun light energy to provide for the planetary attractive and pushing forces, the earth is the only planet with an abundance of water that can easily transform into the state of liquid, ice or gas. It is like a servo-regulator for solar system through the ocean tidal wave and wind actions, the cloud and rain cycles, and the cycles of changes from light to matter and vice versa that was achieved on earth and in the solar system. This would remind the human kind on earth of more prudence and responsibility than ever realized. Effective measures and actions must be taken to reduce the use and waste of human, energy and material resources and stop global warming, pollution and weather bifurcation in order to prevent and ease the occurrence of disasters and to conserve and cultivate the earth for our own happy longevity and that of the generations to come.

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Appendix: Additional Figures



Figure A-1. A map of the Gulf of California in northern United Mexican States, where the Colorado river is in the north of the gulf (scanned map).



Figure A-2a. Map of the Arctic ocean. The Bering strait is located at the top and the Norwegian sea at the bottom of the map (courtesy of the internet).



Figure A-2b. Map of the Antarctic landmass (courtesy of <http://www.cia.gov/cia/publications/factbook/geos/ay.html>)



Figure A-3. Sunset cloud on mountain Tamalpais State Park from the Pacific ocean in San Rafael, California, USA. Mercury, moon, Venus, Saturn and Mars are clustered together with the Sun. (color photo, San Rafael hill on June 16, 2004 at 20:30).



Figure A-4. An uprooted tall pine tree on a hill in the Olympic National Park, Port Angeles, Washington state, USA in April 2001 (Person of height 1.79m standing on fresh snow in front of the tree roots).

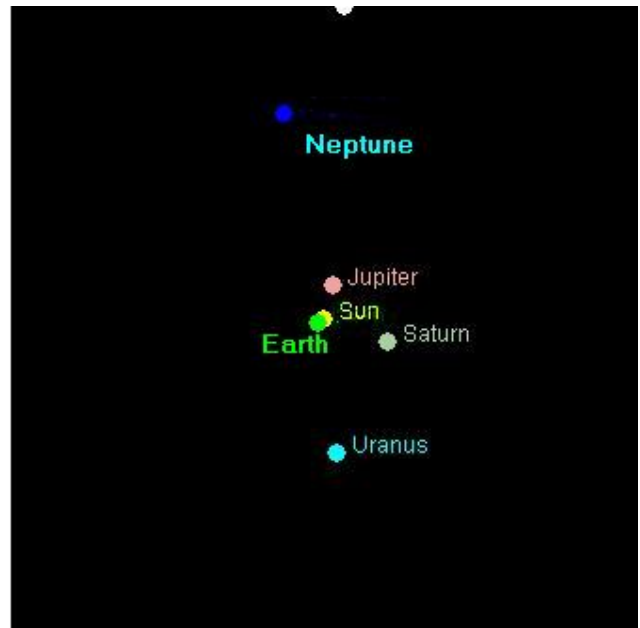
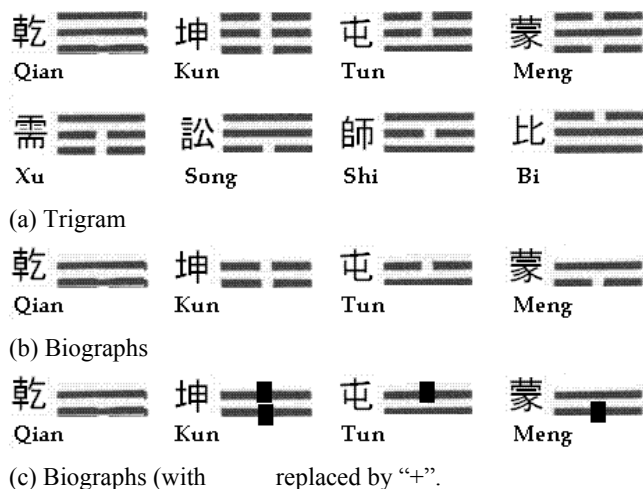


Figure A-5. The outer planets of the solar system in the San Francisco dawn sky at time 05:15 am on April 18, 1906 at the time of the 8.25 Richter scale earthquake. Plotted with the Planet Finder software by Crowell (false color plot).



(c) Biographs (with __ __ replaced by “+”).

土 士

(d) The Chinese characters of “Tu” and “Shi” that look like the “Tun” biographs above.

Figure A-6. (a) The eight trigrams, (b) the four biographs and (c) the four biographs expressed with a different symbol, and (d) Chinese characters that resemble the “Tun” biographs in (c) for the book of Yi Jing (I Ching) – Zhou Yi (2852 B.C.). The corresponding Chinese characters and their Mandarin pronunciations are written to the left of the line graphs or symbols. The broken line “__ __” can be replaced with the Chinese character “+” which represents “SHI” (food, ten, etc.) or the earliest sketch of a plant sprout or a tree in a different writing style. The eight or four Chinese characters are taken directly from their linear sequence in the above book. Notice, the same trigrams of (a) were associated with different Cantonese pronunciations or Chinese characters in the recent English translation of the book by Legge (1882). The eight Chinese characters from Legge’s translation were taken from the diagonal line of the 8 x 8 hexagram table. This diagonal of characters would lead to erroneous interpretations. In the trigrams of (a), a trigram visually resembles a certain part of the corresponding Chinese character as much as was uniquely allowed by the trigrams. The biographs lacked the top line of the trigrams. The “Tun” biographs in (c) looks like the Chinese characters “Tu” (soil) or “Shi” (guard or person). These biographs clearly represent certain basic meanings of the four Chinese characters, that is, Qian (walking path, river, animal meat), Kun (plant food), Tun (place to store food), and Meng (cover and hide the food from animals). This would indicate that the biographs preceded the trigrams in the creation of the trigram or hexagrams for the book. Further, it is also likely that the first 4 biographs started with title “Yi”, that is “Yi Qian Kun Tun”. Such alternative biographs also resemble parts of the corresponding Chinese characters and have certain corresponding meanings as: Yi (walk, flow), Qian (trees, plant and animal food), Kun (soil, arrow and bow) and Tun (store and cover food).