A SUFFICIENT REASON FOR FALSE RB-SR ISOCHRONS

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Abstract

A mathematical answer is presented for the frequent occurrence of false or 'fictitious" Rb-Sr isochrons. The reason for these inconsistencies is that a simple linear regression procedure is mathematically invalid if two or more independent variables influence a single dependent variable. In many data sets for the "isochron" procedure, there are two independent variables involved. First, there is the desired radioactive relation between the amount of the rubidium parent and the strontium daughter. Second, since the atomic strontium concentration in the samples is a variable, then the isotopic Sr-87 content of the atom is also a variable. In such a situation, the "isochron" regression is mathematically invalid, so both its slope and intercept are erroneous.

Introduction

The geological literature is filled with references to Rb-Sr isochron ages that are questionable, and even impossible. Woodmorappe (1979, pp. 125-129) cites about 65 references to the problem. Faure (1977, pp. 97-105) devotes his chapter seven to possible causes for "fictitious" isochrons. Zheng (1989, pp. 15-16) also cites 42 references.

Zheng (pp. 2-3,5) also discusses the frequent occurrence of a variable Sr-86 (another non-radioactive isotope of strontium) that is critical to the situation. He comes closest to recognizing the fact that the Sr-86 concentration is a third or confounding variable in the isochron simple linear regression. Austin (1994, 1992, 1988), Butler (1982), and Dodson (1982 also discuss the discordant and long ages given by the Rb/Sr isochron. Snelling (1994) discusses numerous false ages in the U-Pb system where isochrons are also used. However, the U-Th-Pb method uses a different procedure that I have not examined and for which I have no data. Many of the above authors attempt to explain these "fictitious" ages by resorting to the mixing of several sources of magma containing different amounts of Rb-87, Sr-87, and Sr-86 immediately before the formation hardens. Akridge (1982)) Armstrong (1983), Arndts (1983), Brown (1986, 1994), Helmick and Baumann (1989) all discuss this factor in detail. I do not discuss mixing in this paper; because if my premise is valid that the error is in the isochron procedure itself, then mixing is moot as far as ages are concerned. If the inputs to the mixing equation are data composed of ratios where the divisor is a variable, then the output is invalid.

All the Rb-Sr ages are in the millions to billions of years range, hence they are all completely at variance with the Biblical, literal six days of creation less than 10,000 years ago. Brown goes into considerable detail on this controversy. If the isochron ages are invalid, then a review of his analysis is in order.

Many theories have been advanced in the geological, mineralogical and similar fields to explain the "fictitious" ages, and how to, if possible, "correct" the false ages or to determine the correct age. This paper does not address the geological aspects of the problem. Zheng (1980, p. 3) comes closest to the answer presented here in his analysis of several sets of data containing variable Sr-86 values. However, he misses the true mathematical error in the isochron process, then proceeds to attempt (p. 7) a correction procedure for the variable Sr-86.

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The Simple Linear Regression Line

My answer to the problem is a little recognized mathematical law of the simple linear regression line (SLRL): the procedure applies *ONLY* to the case where *ONE* independent variable influences *ONE* dependent variable. If another variable, called the "third" variable by Johnson (1980, par. 3, p. 477) and the "confounding" variable by Moore (1985, p. 218), also affects the single dependent variable then the procedure is invalid. Figure 1 shows what happens under these circumstances, especially when the third variable affects both radioactive variables as is the case with the isochron procedure. A simple data set, plotted in Figure 1, is:

X	Y	Variable Z divisor
1	5	4
2	6	4
3	7	2
4	8	2

The data have a simple linear regression line of Y = 4 + 1*X with a correlation coefficient *r* of 1.00. The slope is one (45 degrees) and the intercept is four.

If the data set is divided by a variable Z (a purely arbitrary sequence in this sample), and a SLRL is computed for the quotients, then the equation is:

$$Y = .786 + 1.67X. \qquad (1)$$

Note that the slope and intercept are quite different from the original regression, and the points are now scattered, so the correlation coefficient is now 0.993, the slope is 167% of the original, the intercept is 22%, the X mean 42.5%, and the Y mean 39.4% of the original line. Both terms of the deviation from the mean $(x - \bar{X})$ and $(y - \bar{Y})$, an important factor for computing the slope, are modified.

The SLRL slope no longer represents the relation between the variables in the original set in any respect. It also does not represent the relation between the variable Z and the dependent variable Y. The results are quite incoherent.

In contrast, when the original data are divided by a constant of 3 (the mean of the variable divisor), as is also shown in Figure 1, the slope, the fundamental relationship between the variables is unchanged. The intercept is 1/3 of the original, and the range is 1/3 of the original. No such simple relationship exists when the divisor is a variable. The reason is that the basic equation for the slope is a complex, nonlinear relation between the variables, their means, and deviations:

$$m = \frac{\Sigma(x - \bar{X})(y - \bar{Y})}{\Sigma(x - \bar{X})^2} \quad (2)$$

(Johnson, 1980, p. 106, eq. 4-3).

Once the division by a variable is done for the input to the regression, the error is unpredictable and irrevocable. Note that this sample is somewhat different than the normal third variable situation. Both variables are affected, rather than just the dependent one, as Moore (1985, p. 118) illustrates. The confounding is compounded.

The Rb-Sr Isochron Procedure as Normally Applied

The Rb-Sr isochron involves two key processes. First is the division of the radioactive parent (independent variable) by the so-called "constant Sr-86 isotope" and the division of the radioactive daughter (dependent variable) by the same Sr-86 value. Faure (1977, p. 77) states, just above his equation 6.3,

> . . . we can modify Equation 6.2 by dividing . . . by the number of Sr-86 atoms which is constant because this isotope is stable and is not produced by the decay of another element.

This is true; the isotope Sr-86 itself is invariable, and is nominally a constant percentage of the strontium atom concentration. However, Faure does not say that the amount of Sr-86 must be the same in every sample used in the simple linear regression equation. Austin (1994, pp. 111-131) does not address the division at all; he simply uses the Sr-87/Sr-86 and Sr-87/Sr-86 ratios in his illustrations of the isochrons. He does say (p. 118): "The isochron method . . . is used most frequently with isotope ratios . . ." There is again no reference to the fact that the divisor must be a constant amount for all samples in the regression. None of the cited references except Johnson (1980) and Moore (1985) note this fact.

The second step is to compute a simple linear regression with the ratio quotients. The slope of this "isochron" is supposed to yield the age of the formation, and the zero X-intercept is supposed to yield the original daughter content of the formation as it hardened. However, the SLRL is mathematically invalid, because there is a third variable involved: the variable non-radioactive Sr-87 isotope in the atomic strontium present.

Figure 2, using data from Austin (1994, p. 125, Table 6.5) copied in Appendix I, shows that the amount of the Sr-86 isotope is very closely related to the variable amount of atomic strontium. Also, the Sr-86 column in the table confirms that Sr-86 is a variable.

The atomic strontium is, of course, combined with other elements to form the rock minerals, and the isotopes cannot be isolated chemically. They can only be separated in the mass spectrometer and evaluated against a chemical standard "spike." This is actually where the ratios are evaluated as a division quotient.

When the parent Rb-87 is divided by the variable Sr-86, the variable itself, its mean and deviation are changed as in the example above. When the Sr-87 data are divided by the Sr-86 variable, the same thing happens, but in a more important and unusual way.

Figure 3 is a regression between the Sr-87 and Sr-86. It shows that they are very nearly collinear (parallel), with a small constant offset at the X = 0 intercept. The SLRL is:

$$\text{Sr-87} = 0.0586 + 0.6973 \cdot \text{Sr-86}. \quad (3)$$

This SLRL relation can be substituted for the Sr-87 in the ratio:

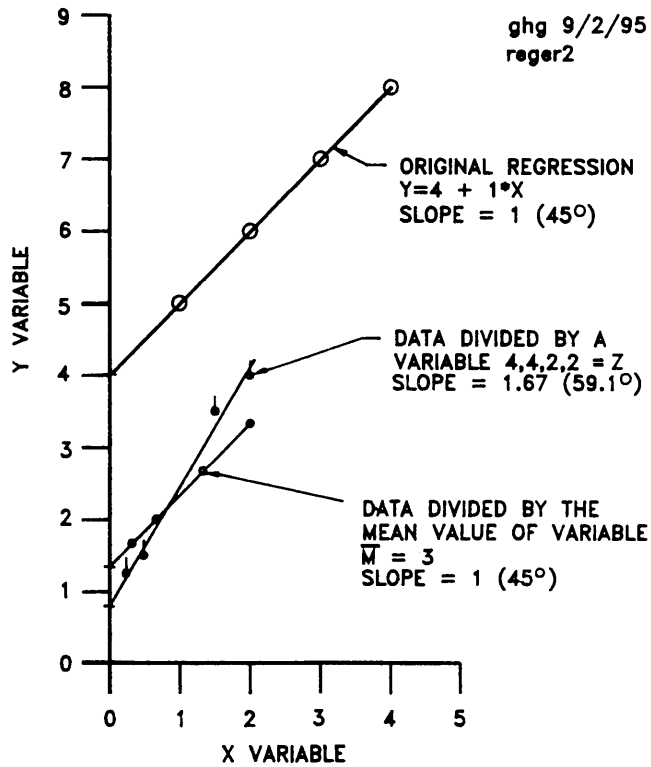

Figure 1. Simple linear regression line when data is divided by a constant and a variable.

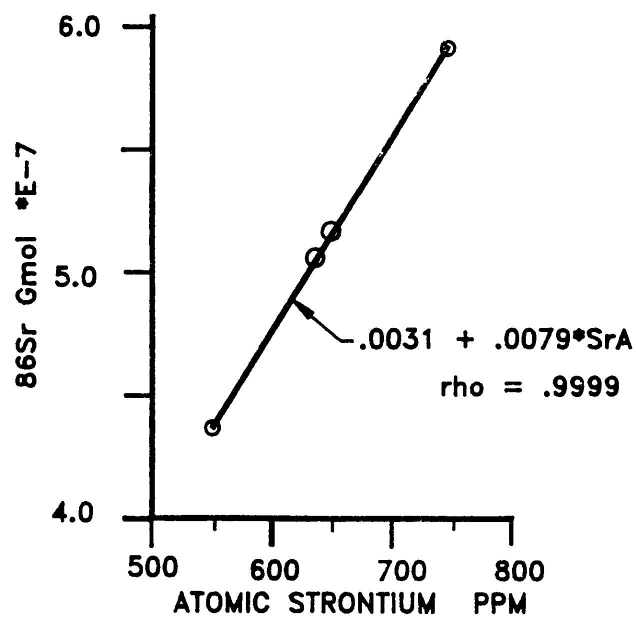

Figure 2. Relation of atomic strontium to isotope 86Sr; they vary together.

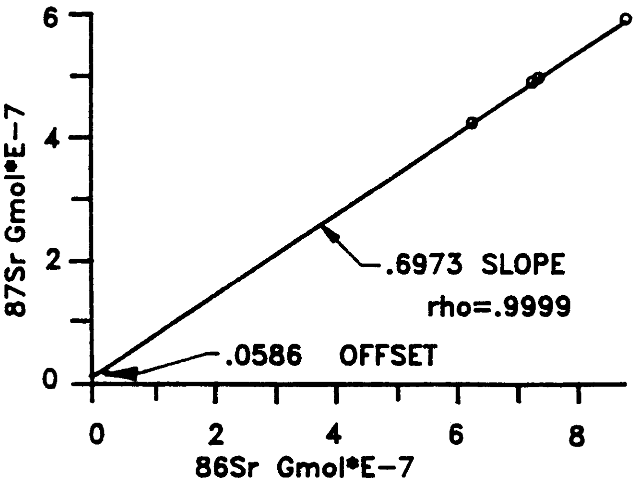

Figure 3. 86Sr and 87Sr are nearly colinear variables.

$$\frac{\text{Sr-87}}{\text{Sr-86}} = \frac{0.0568 + 0.6973^{*}\text{Sr-86}}{\text{Sr-86}} = \frac{0.0586}{\text{Sr-86}} + 0.6973. \quad (4)$$

Thus, the division results in the constant 0.6973 plus a new variable: 0.0586 / Sr-86. This new variable is what determines the Y vertical component of the isochron line. The X horizontal component is the substantially modified mean of the Rb-87 / Sr-86 division noted above. The slope or ratio between the Sr-86 and Sr-87 becomes a constant that, when the Y component of the slope is added to it, is the Y axis locus of the line's center of moment.

The composition of the offset 0.0586 is worthy of note. It does have some radioactive daughter, but only in the sense of the one on one conversion of the parent Rb-87 to the daughter Sr-87. It has no information on when the conversion occurred (no time data). Also, it has some Sr-87 from any other nonradioactive sources that contribute up until the time when the samples are analyzed. The important point is that the sources cannot be identified, let alone be quantified from the existing data. Also, the third variable invalidity of the isochron D⁻ intercept removes any time information. Therefore, the isochron assumption that the slope represents a radioactive time is invalid as long as the division by the third or confounding variable Sr-86, the internal atomic strontium component, exists.

Summary

When a sample set of Rb-Sr data contains a variable amount of atomic strontium in the rock or minerals, the isotope Sr-86 is also a variable. So when the radioactive parent isotope Rb-87 and the isotope Sr-87 (containing some radioactive daughter) is divided by the variable Sr-86, a "third" or "confounding" variable is introduced into the quotients. When these quotients are used in the isochron simple linear regression, this regression is mathematically invalidated by the presence of the third variable Sr-86.

The regression does not signal an error; it simply reports an invalid answer. The slope and intercept are both invalid.

In the case where the Sr-87 / Sr-86 regression has an extremely small offset, a condition known as "Ill Conditioned Data" may result. In this situation, another tive to Pearson's correlation coefficient r will report an error as the coefficient will exceed one. This is the case with the Uinkaret Lavas data. In Butler (1982) and Dodson (1982), their high correlation between the Sr-87 and Sr-86 is the result of the collinearity of the two isotopes.

In the SLRL, the near zero slope of the line is also caused by the near collinearity. In the event there is exact collinearity, the two column vectors of the data matrix are proportional and the matrix is singular; a regression of these data would have a slope of zero-no correlation at all. This subject is beyond the subject of this paper. The reader is referred to Anton (1981, pp. 315-320). It is difficult mathematics!

Conclusions

When a variable atomic strontium content exists in a Rb-Sr data set, an isochron computed data set, an isochron computed from the ratios data is erroneous because a SLRL is mathematically invalidated when more than one independent variable influences a dependent variable. This is an absolute mathematical law which cannot be violated.

APPENDIX I
A Sufficient Reason for False Rb-Sr Isochrons
Uinkaret Lavas Rb-Sr Data

Sample No.	Atomic Strontium ppm	87Rb Gmol x E-7	87Sr Gmol x E-7	86Sr Gmol x 10E-7
QU-1	**745**	**0.305**	**5.91**	**8.39**
QU2-2	**549**	**1.00**	**4.37**	**6.18**
QU-5	**634**	**0.371**	**5.03**	**7.14**
QU-14	**649**	**0.958**	**5.16**	**7.31**
QU-14S	**Omitted because of special processing.**			

Ratios from original data omitted.
From Table 6.5, p. 125, Steven A. Austin. 1994. Grand Canyon, Monument to Catastrophy. Special study.

The division of the Sr-87 by the near collinear Sr-86 generates a false variable, which may contain daughter products, but which is also influenced by other nonradioactive values. It does not evaluate the radioactive decay rate relationship between the parent and daughter, so the "isochron line" slope does not measure time at all.

Since the slope is erroneous, its extrapolation from the mean locus of the regression line to the X = 0 axis is also invalid. Hence, the initial Sr-87 / Sr-86 ratio is also invalid.

If the Sr-87 and Sr-86 data are very nearly collinear (parallel), then an additional substantial error is introduced into the isochron regression because the data are ill conditioned. This near collinearity is an inherent property of the data set, the internal atomic strontium isotope composition.

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Quote

Which of his titles is hidden under the chapter heading "The Cosmic Christ"? It is the title "Logos" as found in the opening of the Gospel according to John: "In the beginning was the Word, and the Word was with God, and the Word was God. . . . All things were made through Him and without Him nothing was made that was made." Pelikan comments:

> Because the speaking of God (which is one way to translate Logos) made the world possible, it was also the speaking of God that made the world intelligible. Jesus Christ as Logos was the *Word of God* revealing the way and will of God to the world. As the medium of divine revelation, he was also the agent of divine revelation, specifically of revelation about the cosmos and its creation. His "credibility" was fundamental to all human understanding.

The Christian fathers drew from this insight far-reaching conclusions: "There was, therefore, an analogy between the Logos of God, which had become incarnate in Jesus, and the logos of humanity, which was incarnate in each person and perceptible to each person from within." After certain starts in false directions (a tendency to glorify the irrational on the one hand and a rash claim that the mind has power to know everything about God on the other), the consensus of the Fathers settled on "the cosmos [that] was reliably knowable and at the same time mysterious, both of these because the Logos was the Mind and Reason of God." We have seen how this deep conviction in the fourteenth century led to corrections of Aristotle by Christian scholars that prefigured some of Newton's principles. These utterly new thoughts were passed on through Leonardo to Galileo, so that the astonishing enterprise of modern science was finally being born in Christian culture after several still births in ancient Egypt, China, and Greece.

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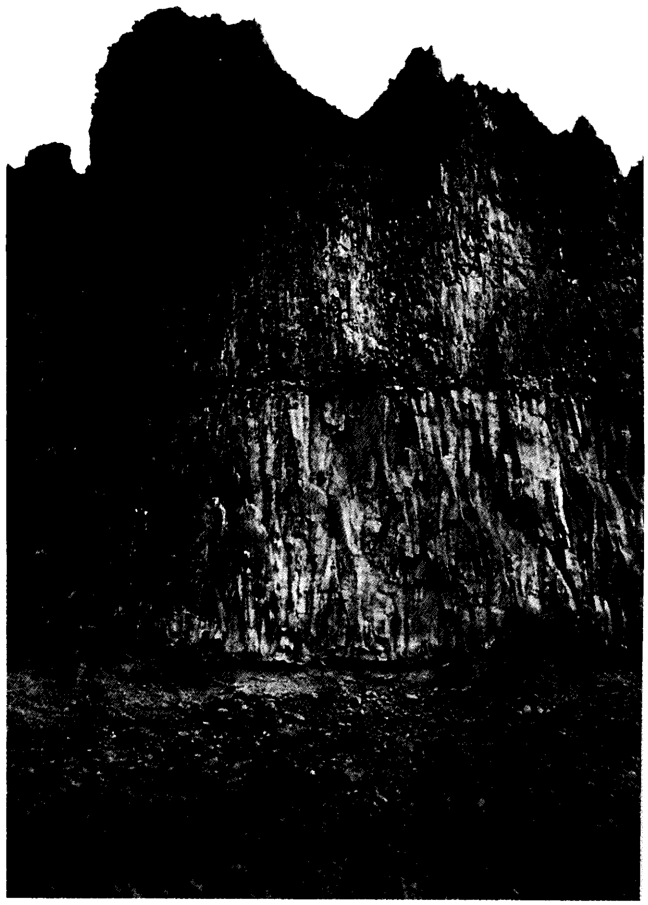

Plateau Basalt Overlying Spokane Flood Deposits. Location is west of Yakima, WA along U.S. 12. This particular exposure reveals the rapid manner in which the basalt lava overflowed the area. The lava flow was catastrophic and provides evidence of massive tectonic forces still in operation following the receding of the Flood waters from this area of the continental U.S. (Ice Age Timeframe). Today geologists have nothing to compare it to other than the Hawaiian Islands. Photograph and caption by Carl R. Froede Jr.

Quote

Psalm 93:3-4

The seas have lifted up, O Lord, the seas have lifted up their voice; the seas have lifted up their pounding waves. Mightier than the thunder of the great waters, mightier than the breakers of the sea--the Lord on high is mighty.