Reverse Versus Thrust Faults

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This note arises from a desire to urgently caution against the ambiguous employment and false interpretation of the word "thrust" in the geometric description and treatment of all high-angle reverse faults. The indiscriminate usage of "thrust" as a descriptive adjective, with no thought as to what the deforming stresses may have been, has crept into geologic literature and into the mental processes of numerous geologists. For example, in the well-assembled and concisely written text "Geology, Principles and Processes" by Emmons, Thiel, Stauffer, and Allison, which was recently revised (1939), the term thrust and reverse are loosely used. Figure 388 (page 358) illustrates, in geometric description, a normal fault as compared to a reverse fault structure, but the reverse fault has there been unsuitably labeled "thrust". Again, on page 359, it is inferred, if not stated directly, that thrust and reverse have synonymous meanings. Many other references of like nature can be cited, not only from textbooks of geology, but also from current geologic journals and periodicals.

Willis, in defining the terms normal fault and reverse fault, writes as fol lows:[1] "A fault which was the reverse of normal was a reverse fault. These old terms have outlived their usefulness and have gathered a number of misconceptions, but they are so firmly fixed in the nomenclature of geology that they must be continued in use, though we should try to avoid the false interpretations with which they are too often associated."

Regardless of whether high-angle and low-angle may constitute more suitable descriptive terms we are, as Willis believes, probably obliged to continue the use of the words normal and reverse in fault terminology. The fact that geology is not an exact science should not preclude the proper use of terms and descriptions, especially when certain designations have been made and defined. "Geology suffers accordingly, for loose language is the expression of loose thinking and leaves the reader in doubt as to the value of the observations which it records," Willis.[2]

Members of the Geological Society of America early realized the importance of standardization of fault nomenclature. This Society, in an effort to overcome ambiguity and inconsistency in the descriptive treatment of faults, appointed a committee in 1908 to study and formulate principles for the nomenclature of faults. The report of this committee, published in 1913, has become accepted as the authority of fault terminology. Reverse faults are therein defined[3] as fault structures, "Where the hanging wall has been raised relatively to the footwall," and further it is written,[4] "We recommend that the terms **normal** and **reverse** faults as defined be used purely for purposes of description and not for the purpose of indicating extension or contraction, tension or compression, vertical or horizontal forces." Thus it is apparent that the antonym of normal is reverse, certainly not "thrust", which by its connotation primarily suggests compression. In fact, this point is clearly stated by the Committee on Nomenclature where they list, as one of their guiding principles,[5] the desire "to make the classification (of faults) geometric and descriptive, not genetic, in order that a fault may be described so far as it may have been observed without any inferences as to the forces which produced it. For instance a so-called "thrust fault" may sometimes be formed without any compression, and a "tension fault" without any tension; the terms "thrust" and "gravity" faults . . . should only be used after the forces which produced the fault are understood . . . a dynamic system of classification will be in order when the dynamics of faults is better understood."

Because horizontal movement can, under certain conditions, give the appearance of normal or reverse faulting, even though there has been no vertical stress component during displacement, Nevin,[6] in defining a reverse fault, adds the qualifying adverb that the hanging wall has **apparently** moved up with respect to the foot wall. Willis[7] also qualifies normal and reverse fault terminology by the word **apparent**.

If we grant the premise, or at least assume, that the dynamics of faults are better understood today than they were in 1913, then still further evidence presents itself in support of the contention that "thrust" should not be used in lieu of, or interchangeably with, the term "reverse." Studies of the dynamic relations and the stresses involved in the formation of numerous horst structures indicate that, in many instances, these block like forms have been produced by actual uplift of the block; that is, by vertical uplifting stresses or central "up thrust" adjustments. If the faults which delimit the horst are the normal type, as is frequently the case, then the term "thrust" can be used conveniently to describe the manner of stress causing the resulting fault ridge even though the adjacent faults are of normal type. The particular structures should then be properly called thrust[8] normal faults. When the associated faults are reverse, and the center portion has been proven to be actively "up thrust", then the component structures, which bound the area, may be described as thrust reverse faults.

If "thrust" has a place in geologic terminology, that place is in the treatment of stress relations or in the presentation of dynamic principles. Webster[9] defines the geologic use of thrust as, "a compressive tangential stress in the earth's crust or the effect of such a stress; a thrust fault." Although a thrust fault is therein[10] given as, "when the angle between the horizontal and the plane of a reverse fault is small the fault is a thrust fault or an overthrust fault," this employment of thrust fault is technically not proper even in the geometric description of overthrust or underthrust faults. The term **overthrust** is recommended in lieu of "thrust" by the Committee on Nomenclature[11] when a reverse fault of low dip is being geometrically treated.

To the casual reader the title of this paper may have appeared quite naive. However, the writer is convinced that such a reaction, if experienced, was not directly induced by the title to the degree that it was from the widespread improper use of the term "thrust" fault. The foregoing discussion may be summarized as follows:

"Thrust" and "reverse" are not interchangeable in fault description.

The antonym of normal fault is reverse fault.

Low-angle reverse faults are either overthrust or underthrust faults when described geometrically.

"Thrust" should be used as an adjective to describe the fracture when the strain can be determined to have resulted through thrusting stresses.

The point may be raised that such a terminology is confusing and unnecessary. In the writer's opinion, it is certainly less confusing than the lax treatment now prevalent and, in addition, it coincides with the requirement some authors[12] now find for the use of the terms "thrust" or "upthrust".

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[1]Baily Willis and Robin Willis: **Geologic Structures Third Edition,** McGraw-Hill Book Company, Inc., (1934) p. 148.
[2]**op cit.,** p. 214.
[3]H. F. Ried, **et al: Report of the Committee on the nomenclature of faults,** Geol. Soc. Am., vol. 24 (1913) p. 177.
[4]**Ibid.,** p. 178.
[5]**Ibid.,** p. 164.
[6]C. M. Nevin: **Principles of Structural Geology,** John Wiley & Son, Inc., (1931) p. 83.
[7]**Op cit.,** p. 149.
[8]Nevin and Willis both use "upthrust" as perhaps a more suitable term.
[9]**Webster's New International Dictionary of the English Language Second Addition unabridged,** G. and C. Merriam Company (1936) p. 2638.
[10]**Op cit.,** p. 924.
[11]**Op cit.,** 5, p. 179.
[12]C. M. Nevin: **op cit.,** p. 106.
Baily Willis and Robin Willis: **op cit.,** p. 225-227.