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Abstract

Presumed yearly banding is a common feature in stromatoporoid skeletons. Several dozens of cut and polished sections of stromatoporoid colonies ranging from Pragian to Frasnian with obvious growth "rings" considered to be yearly skeleton accumulations, have been investigated for multi-year quasi-periodical growth patterns. The aim of the study was to detect and interpret such patterns.

Background

A continuous wavelet transform is used to divide a continuous-time function into wavelets. Unlike Fourier transform, the continuous wavelet transform possesses the ability to construct a time-frequency representation of a signal that offers very good time and frequency localization. In mathematics, the continuous wavelet transform of a continuous, square-integrable function x(t) is expressed by the following integral

$$X_w(a,b) = \frac{1}{\sqrt{|(a)|}} \int_{-\infty}^{\infty} x(t)\psi^*\left(\frac{t-b}{a}\right) dt$$

where ψ(t) is a continuous function in both the time domain and the frequency domain called the mother wavelet, b is the translation factor, a is the scale factor and * represents operation of complex conjugation. The main purpose of the mother wavelet is to provide a source function to generate the daughter wavelets which are simply the translated and scaled versions of the mother wavelet. To recover the original signal x(t), inverse continuous wavelet transform can be exploited.

Methods

Polished radial sections of stromatoporoid colonies were photographed to obtain digital images. Subsequently, each cross-section image was processed in an image editor so that a synthetic linear 'profile' devoid of deformations, impurities, calcite veins, styloliths and other secondary intervening features was obtained for every cross-section. From these profiles a signal of mean gray level was obtained by averaging the

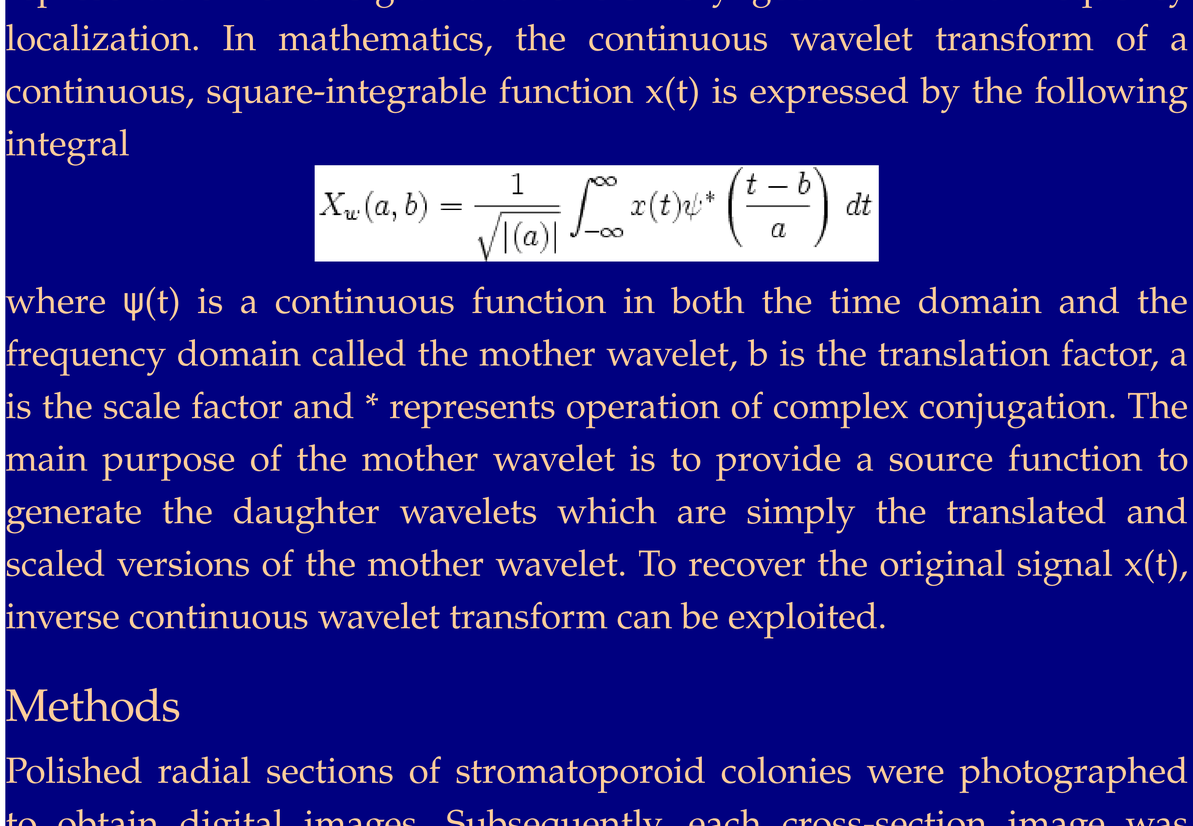

Fig. 1. Processing of raw data into numerical values, illustrated by BySk-1 specimen: Actinostroma, Middle Givetian, Moravia (Josefov - Býčí skála Cave, Lazanky Mb.). Left: raw cross-section through the stromatoporoid colony skeleton, four columns represent lateral walls of a prism cut from the skeleton.

columns of pixels subsequently turned to numerical values. Indeed, such profiles do not represent growth rate vs. time, but rather the abscissa is just a monotonic function of time.

Further, we applied a continuous weavelet transform using the Gaussian wavelet (the commonly used Morlet wavelet is inappropriate due to its complex form to unveil simple growth periodicities).

The following specimens were investigated:

1 - *Actinostroma*, Middle Givetian, Moravia (Josefov - Býčí skála Cave, Lažánky Mb.)
2 - *Glyptostroma*, Lower Emsian, Bohemia (Dobřichovice - Karlík Valley, Zlíchov Mb.)
3 - *Actinostroma*, Lower Frasnian, "marble plate from Brilon area"
4 - *Trupetostroma*, Lower Frasnian, "marble plate from Brilon area"
5 - *Stictostroma*, Middle Frasnian, Moravia (Mokrá Section, -48 m mark, Vilémovice Mb.)
6 - *Actinostroma*, Middle Frasnian, Nevada (Little Mile-and-a-Half Canyon, Guilmette Fm.)
7 - *Actinostroma*, Lower Emsian, Nevada (Lone Mountain - Bartime Mb.)
8 - *Hermatostroma*, Upper Frasnian (Low. rhenana Z.), Moravia (Mokrá Section, -25 m mark, Vilémovice Mb.)
9 - *Atopostroma*, Middle Pragian, Barrandian (Koněprusy, at the toe of Zlatý kůň Hill, Koněprusy Mb.)
10 - *Parallelopora*, Middle Pragian, Barrandian (Koněprusy, at the toe of Zlatý kůň Hill, Koněprusy Mb.)
11 - *Actinostroma*, Middle Pragian, Barrandian (Koněprusy, at the toe of Zlatý kůň Hill, Koněprusy Mb.)
12 - *Stictostroma*, uppermost Emsian, Barrandian (Hlubočepy, Třebotov Mb.)

Results

A unique specimen of a Givetian stromatoporoid *Actinostroma* from Josefov - Býčí skála Cave (Fig. 1) registered three growth regimes: (1) two zones of growth deceleration within a one-year cycle, corresponding to recent rhythms in the monsoonal realms, (2) regime with the single growth deceleration within a year cycle, known for instance on the west coast of Atlantic, and (3) extremely varying regime, analogous to that in the realms of frequent storms, as known for instance from the neighborhood of todays Japan.

The same specimen was analyzed for multi-year periodicities. The continuous wavelet transform scaleogram, both raw and normalized by global wavelet, shows quite distinct 4-8 year periodicity (e.g., at ca. 512 pixel level in Fig. 2, compared to presumed yearly periodicity at ca. 128 pixels).

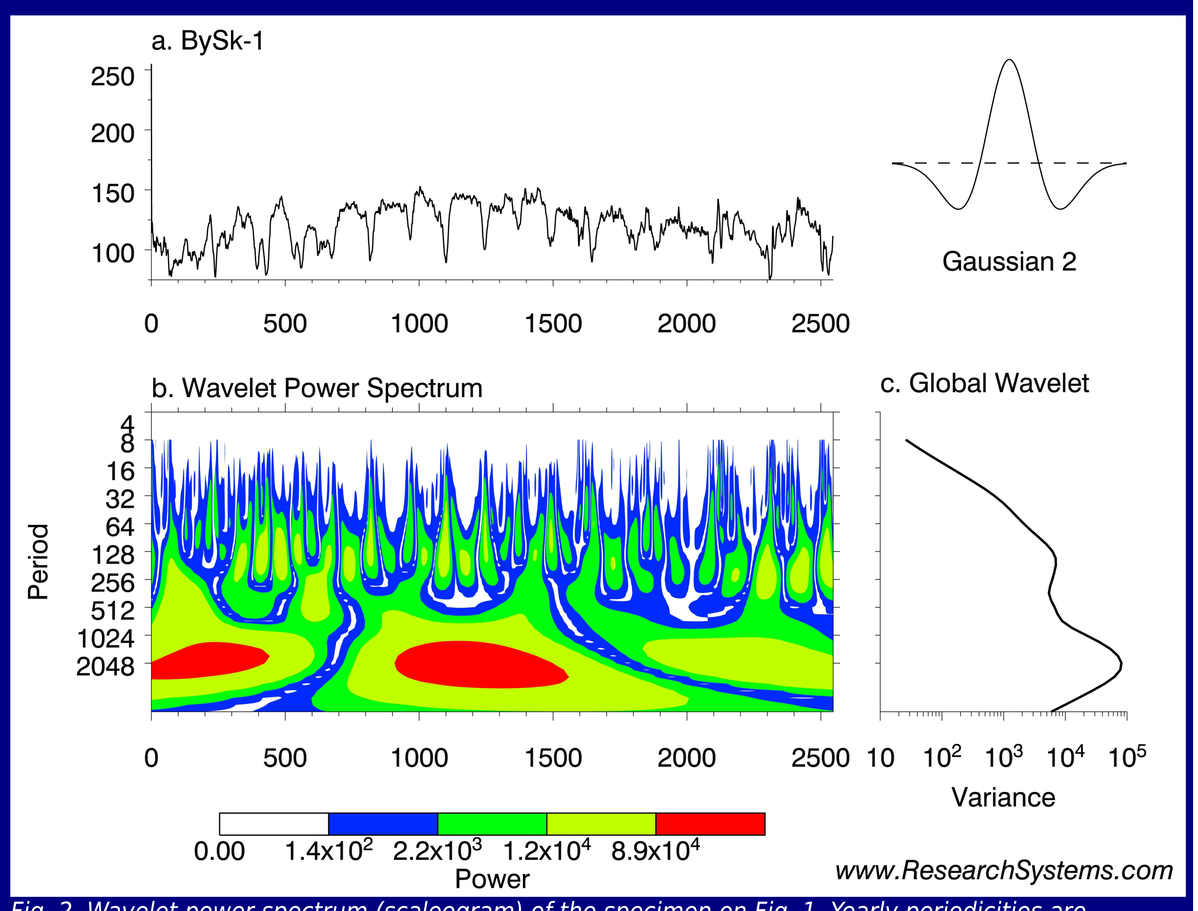

Fig. 2. Wavelet power spectrum (scaleogram) of the specimen on Fig. 1. Yearly periodicities are between 64 and 128 pixels, with overloaded periodicity at about 2048 pixels.

All other investigated samples of different stromatoporoid taxa support the hypothesis of multi-year growth periodicity superimposed on the supposed yearly growth rhythms. The control of this periodicity remains the subject of further study.

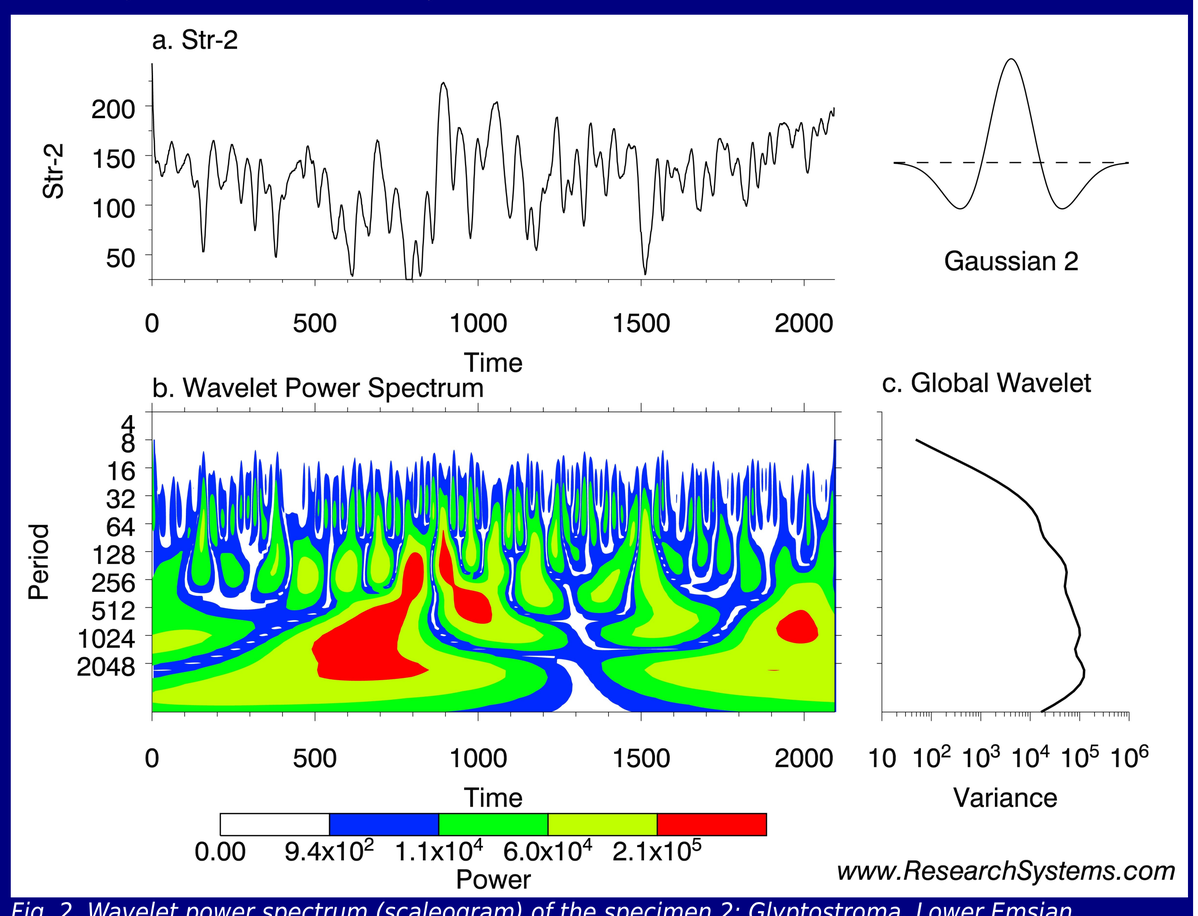

Fig. 2. Wavelet power spectrum (scaleogram) of the specimen 2: Glyptostroma, Lower Emsian, Bohemia (Dobrichovice - Karlik Valley, Zlichov Mb.) . Yearly periodicities are between 128 and 256 pixels, with overloaded periodicity at about 1024 pixels. 1 pixel = 40 micrometers.

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