[PS]Using Phytoliths and Carbon Isotope Stratigraphy to Recognize Subtle Subsurface Unconformities in the Unayzah Group of Saudi Arabia*

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Abstract

Unayzah Group correlation in Saudi Arabia is hindered by the lack of terrestrial fossils preserved in oxidized red-beds. Phytoliths are biogenic siliceous plant infillings and casts resistant to oxidation. In previous studies the presence of Biogenic Silica microfossils (Phytoliths) in Unayzah Group deposits were confirmed. Although some may have been deposited by wind, we believe the bulk of the phytoliths preserved within the Unayzah red-beds comprise the remains of both hot- and cool-desert, restricted plant communities (i.e., biocoenoses) that persisted during deposition of the upper Unayzah. New Phytolith fossils observed in the present study and from Permian red-beds from Texas demonstrate a clear link with Permian plants species.

Although severely oxidized, the Unayzah Group red-beds contain sufficient organic matter for carbon isotope analyses. Organic matter $\delta^{13}C$ fluctuations typically reflect atmospheric CO_2 variations. In terrestrial material, however, (including the Unayzah red-beds) $\delta^{13}C$ fluctuations typically observed in other environments (i.e., marine) are overprinted by various organic matter sources. To deal with this limitation, a standard approach has been to measure carbon isotopes on single components (e.g. wood fragments). Unfortunately, in the Unayzah, most organic matter is amorphous and this standard, single-component approach is not possible.

As an alternative, we used the variations in Phytolith assemblages combined with stable carbon isotope stratigraphy to better

understand the Unayzah Group stratigraphy. Variations in Phytolith assemblages were used to reduce the noise in the $\delta^{13}C$ record, enabling correlation of our isotope results to a global standard. This approach, combining quantitative Phytolith analysis with isotope stratigraphy, provides a method for estimating stratigraphic hiatuses and intervals deposited with reduced sedimentations rates. Our work suggests that hiatuses and intervals with reduced sedimentations rates are likely present within the Unayzah Group. Our conclusions are in general agreement with similar conclusions gained using other techniques (i.e., chemostratigraphy) employed by others to correlate these strata.

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Although severely oxidized, the Unayzah Group red-beds contain sufficient organic matter for carbon isotope analyses. Organic matter $\delta^{13}C$ fluctuations typically reflect atmospheric CO_2 variations. In terrestrial material, however, (including the Unayzah red-beds) $\delta^{13}C$ fluctuations typically observed in other environments (i.e., marine) are overprinted by various organic matter sources. To deal with this limitation, a standard approach has been to measure carbon isotopes on single components (e.g. wood fragments). Unfortunately, in the Unayzah, most organic matter is amorphous and this standard, single-component approach is not possible.

As an alternative, we used the variations in Phytolith assemblages combined with stable carbon isotope stratigraphy to better understand the Unayzah Group stratigraphy (Fig. C). Variations in Phytolith assemblages were used to reduce the noise in the $\delta^{13}C$ record (Fig. D and E), enabling correlation of our isotope results to a global standard (Fig. C). This approach, combining quantitative Phytolith analysis with isotope stratigraphy, provides a method for estimating stratigraphic hiatuses and intervals deposited with reduced sedimentations rates (Fig. E). Our work suggests that hiatuses and intervals with reduced sedimentations rates are likely present within the Unayzah Group. Our conclusions are in general agreement with similar conclusions gained using other techniques (i.e., chemostratigraphy) employed by others to correlate these strata.

Figure A

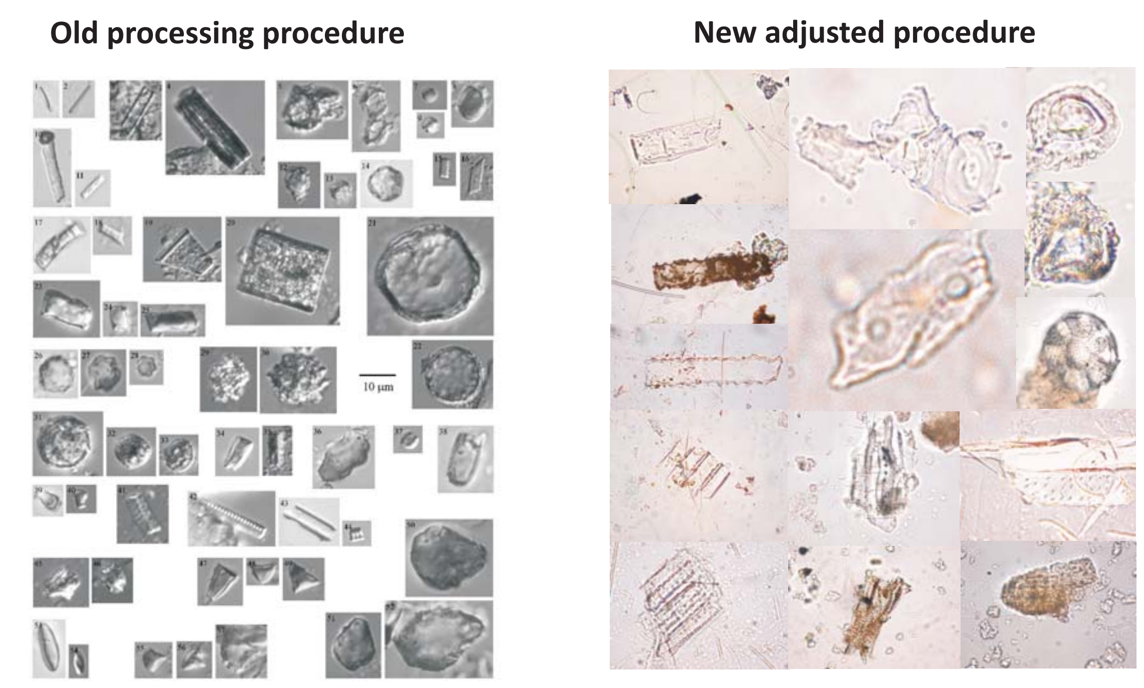

Figure A: Examples of Phytolith morphotypes recovered with an adjusted processing procedure from Unayzah Group deposits (right panel) compared with Phytolith morphotypes using the processing technique applied in the earlier Phase of the project (left panel).

Figure B

Figure B: Distribution of Phytolith taxa encountered in well C.

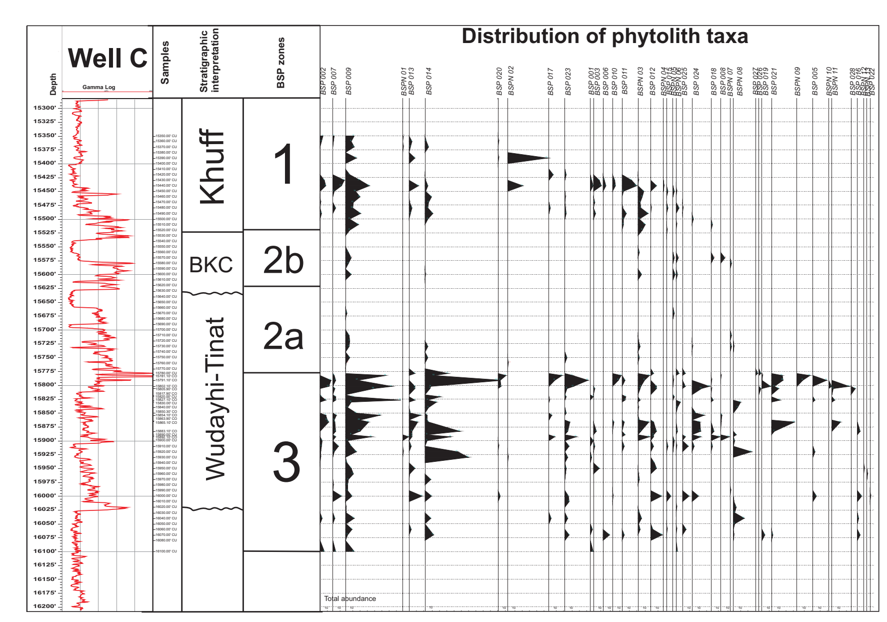

Figure C

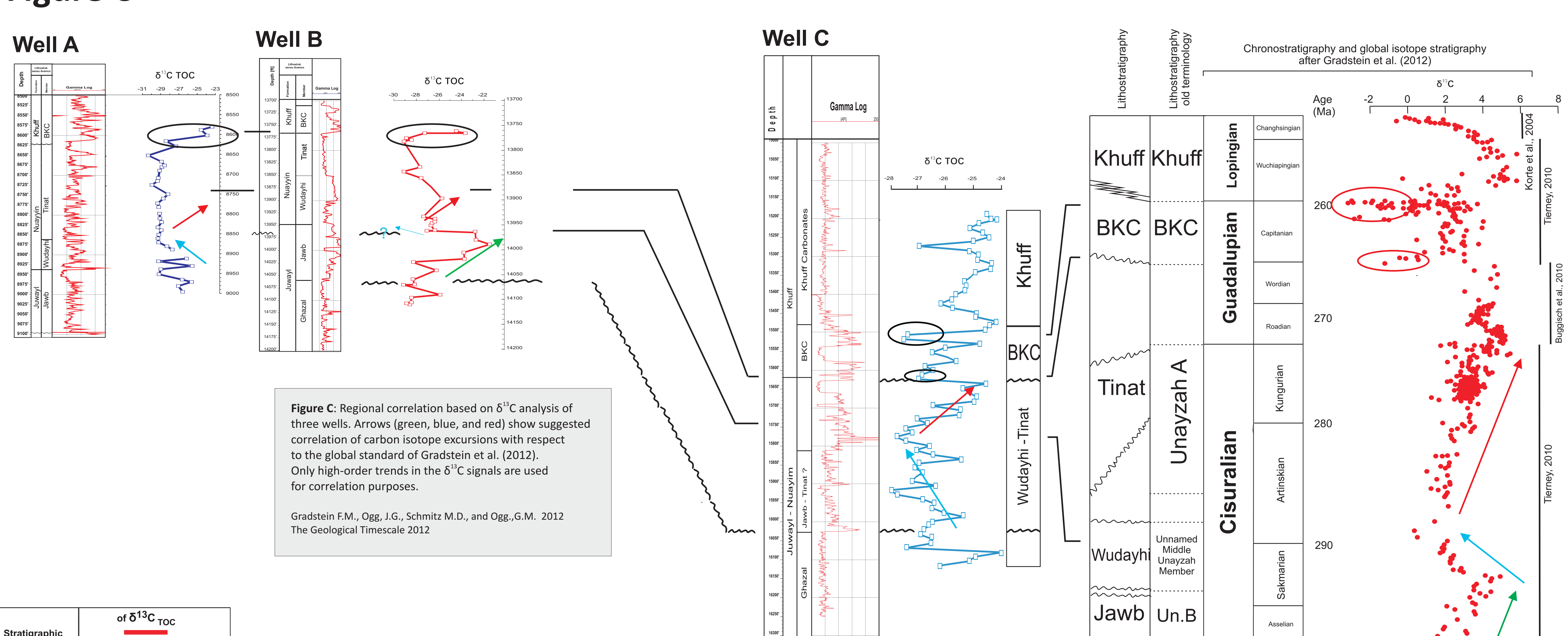

Figure C: Regional correlation based on $\delta^{13}C$ analysis of three wells. Arrows (green, blue, and red) show suggested correlation of carbon isotope excursions with respect to the global standard of Gradstein et al. (2012). Only high-order trends in the $\delta^{13}C$ signals are used for correlation purposes.

Gradstein F.M., Ogg, J.G., Schmitz M.D., and Ogg.,G.M. 2012 The Geological Timescale 2012

Figure D

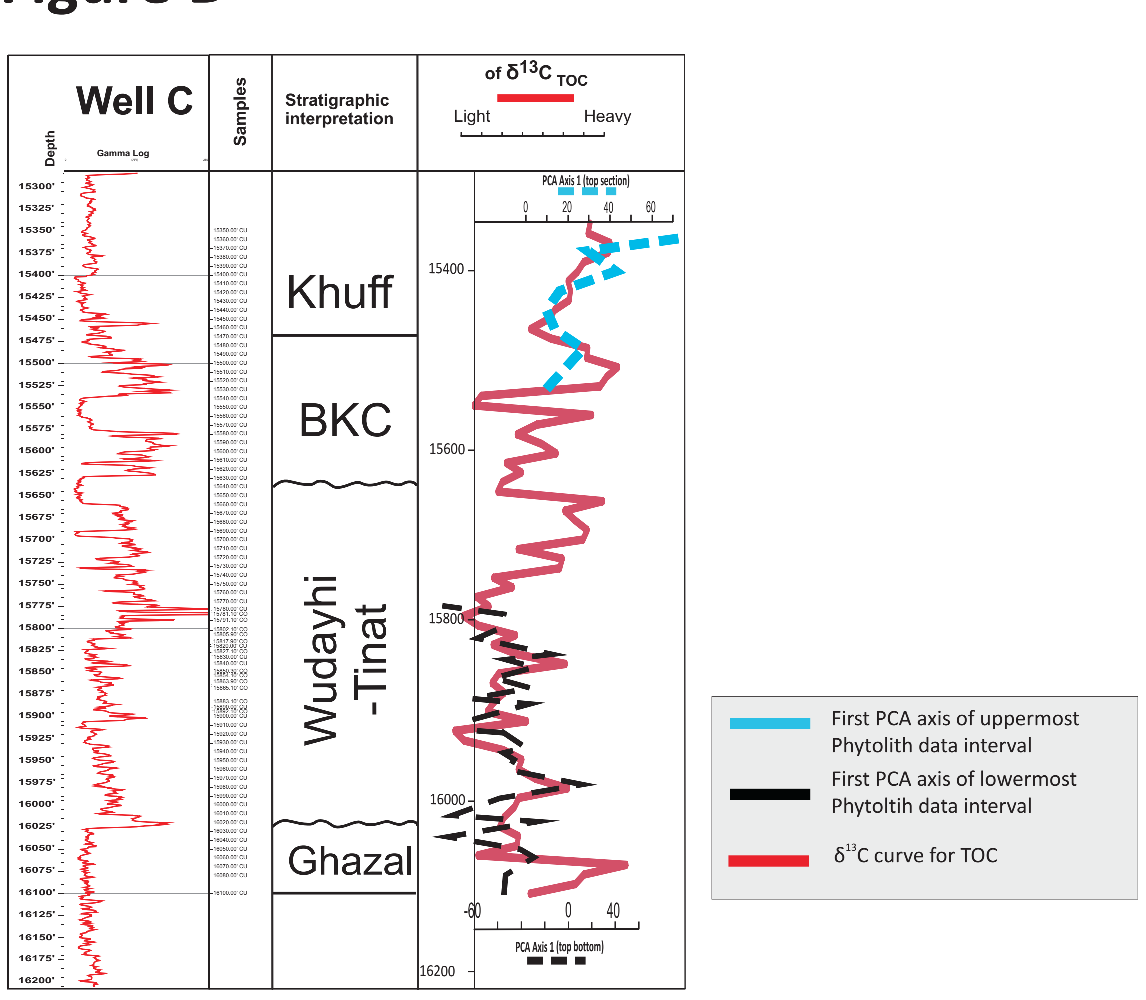

Figure D: First PCA components for Phytolith data are rendered as a dashed-black line for the analyses performed on the lowermost interval and as a light-bue line for the analyses performed on the uppermost interval. These Phytolith data are superimposed on the $\delta^{13}C$ curve for total organic carbon (TOC) for comparison. The good fit suggests that Phytolith assemblages provide a reasonable proxy for organic (plant) facies variations. We speculate that organic (plant) facies variations may drive short-term carbon-isotope excursions.

Figure E

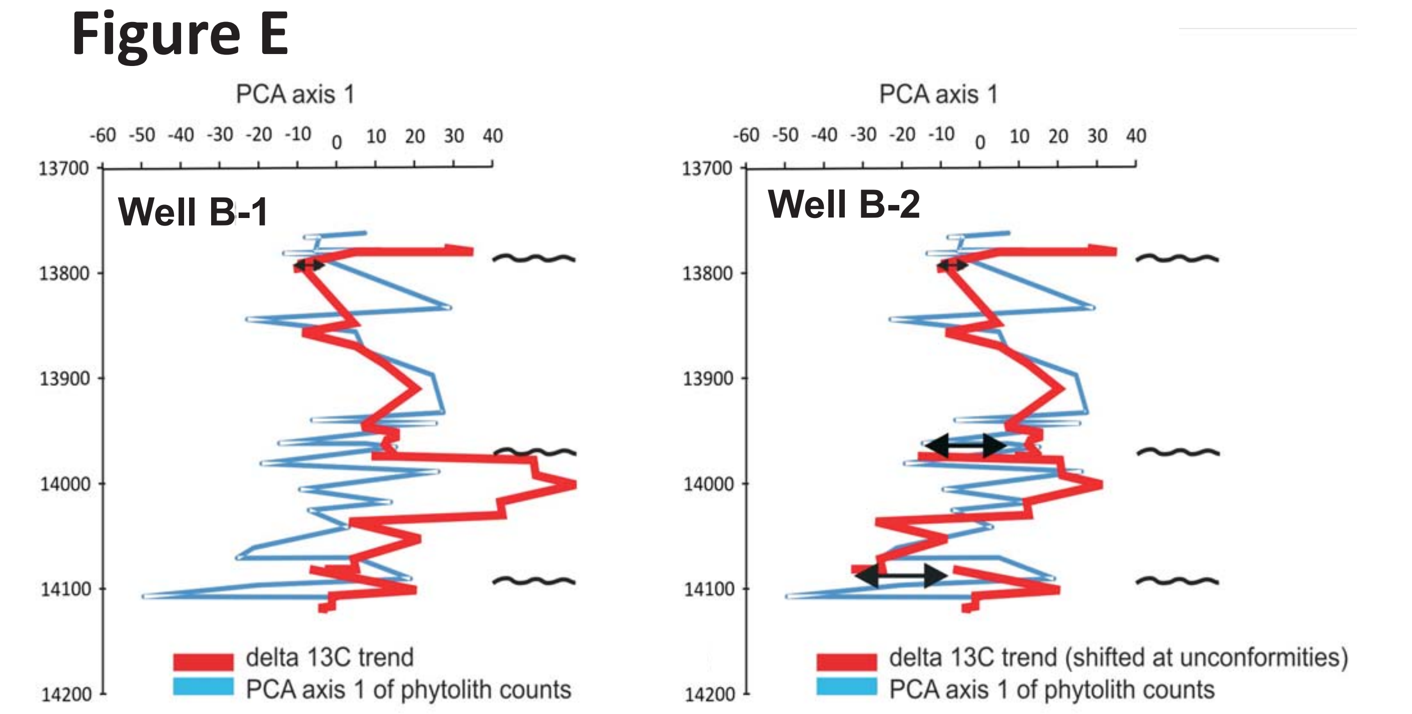

Figure E: (Well B-1) Comparison of the first component of the principal component analysis (PCA) axis of Phytolith data of well B to the $\delta^{13}C$ data of the same well. (Well B-2) When the $\delta^{13}C$ curve is shifted 4 per mille at the unconformities, towards more positive values, the results is a good match with the Phytolith PCA curve. This example shows how Phytolith facies analysis combined with carbon isotope analysis can help trace subtle unconformities in Unayzah group deposits.

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