

# COMPARISON OF FRACTURE PLANES IN THE MARCELLUS AND UTICA SHALES

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## INTRODUCTION

Horizontal drilling and hydraulic fracturing have opened up shale plays to new or continued production. Operators seeking to produce oil, gas, or condensate need to understand the natural and induced fracture patterns within the shales. Surface and near-surface microseismic monitoring allows for the identification of focal mechanisms which indicate the mode of rock failure within the shale. Additionally, as new shales in familiar basins, such as the Appalachian, become more profitable, patterns and similarities within the basin are crucial to understanding treatment and completion techniques.

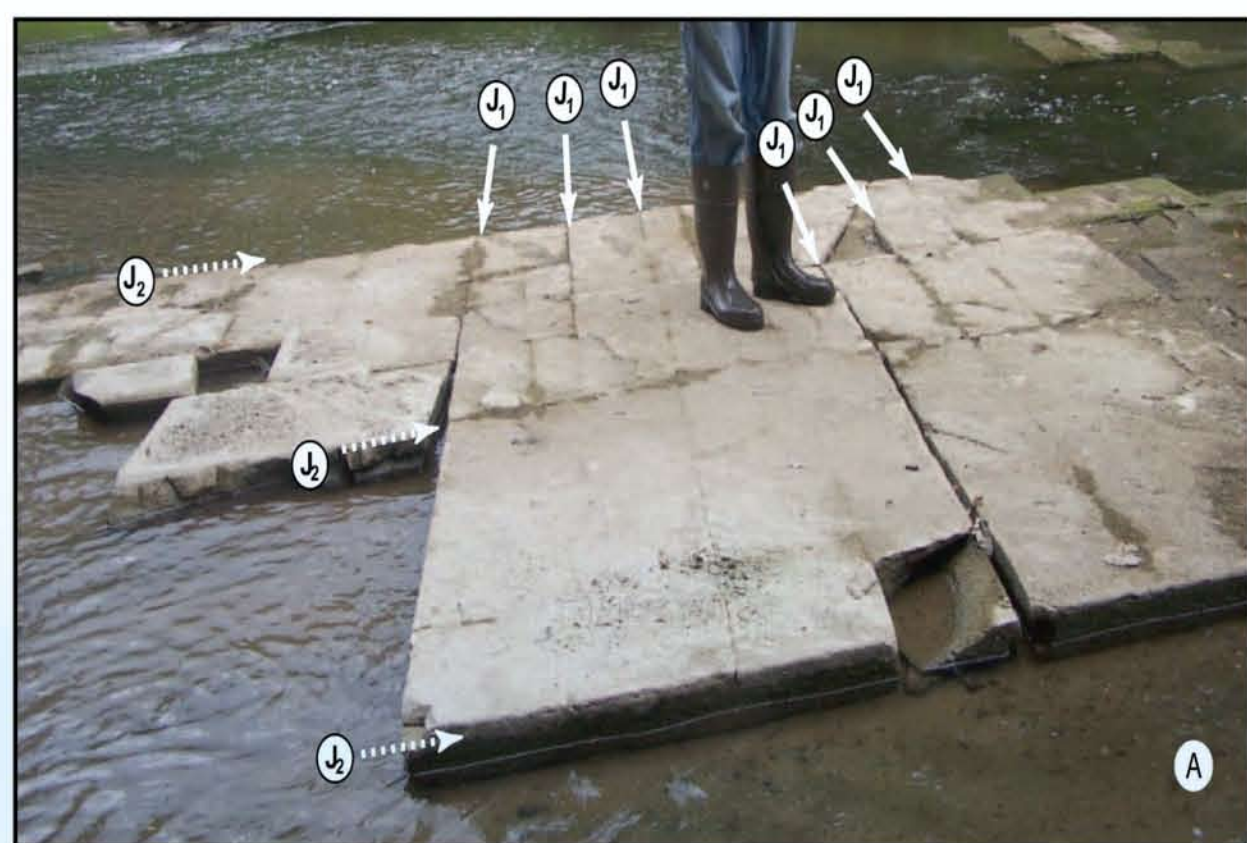
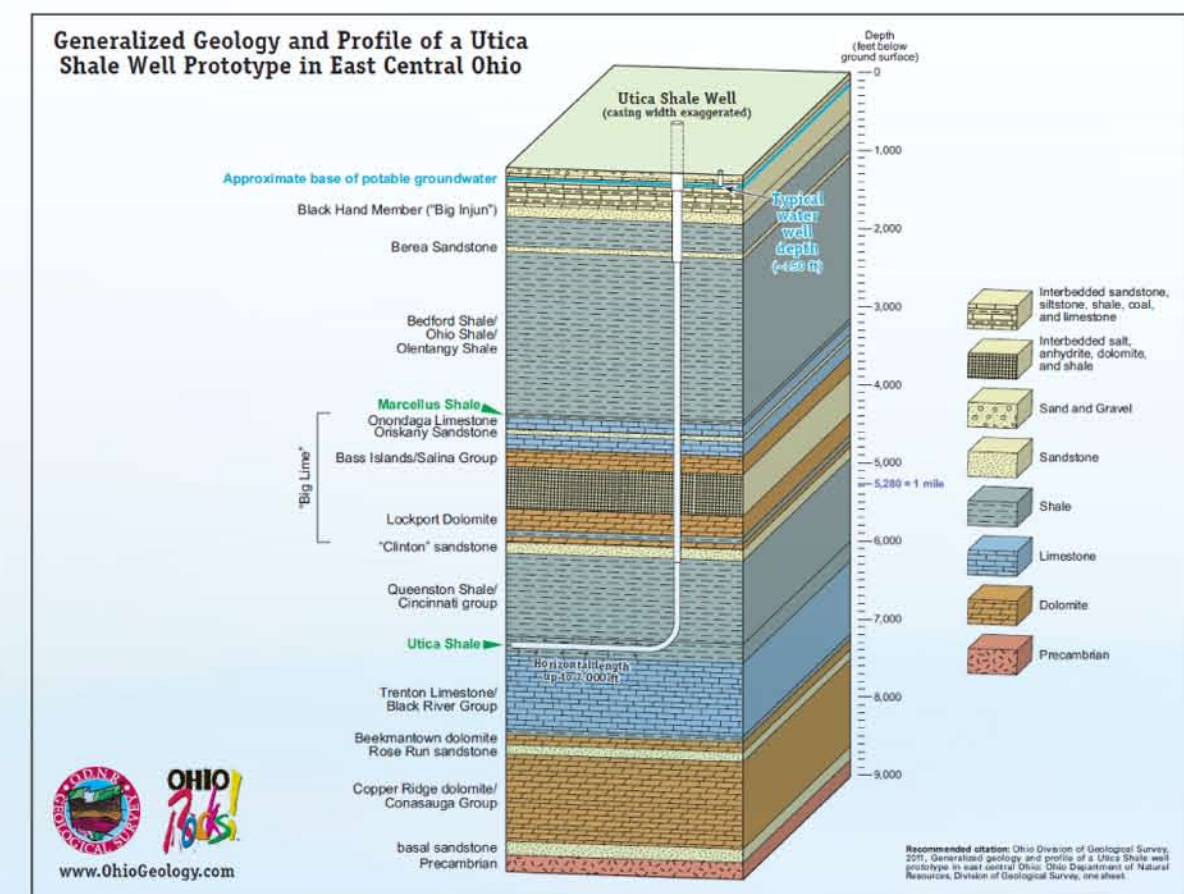
## BACKGROUND

### UTICA

- Deposited in the late Ordovician (450 to 440 Mya)
- Organic-rich calcareous shale with low water saturation
- Terrigenous material was eroded from the Taconic orogeny
- Overlying the Trenton limestone

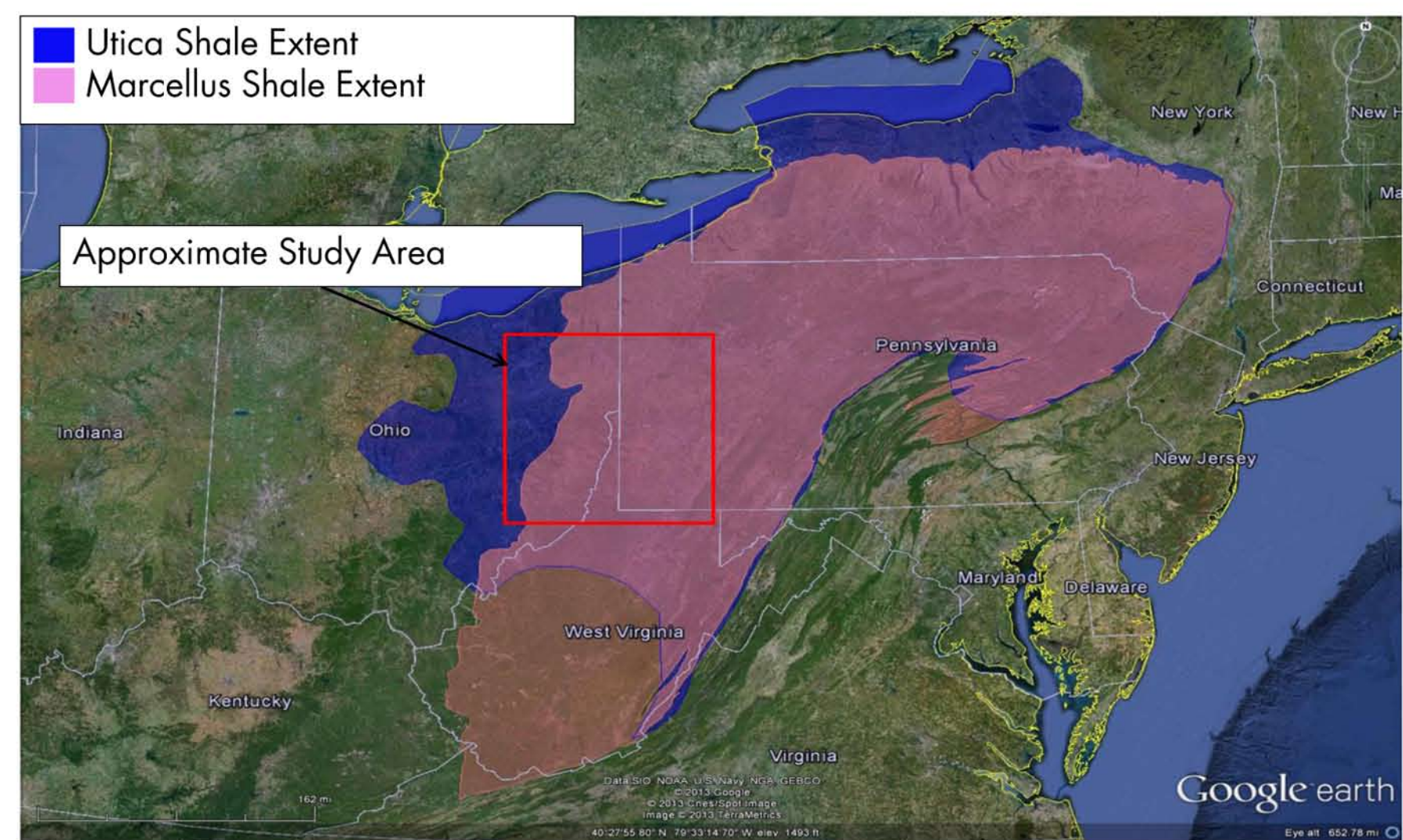
### MARCELLUS

- Deposited in the middle Devonian (393 to 382 Mya)
- Organic-rich shale
- Terrigenous material was eroded from the Acadian orogeny
- Overlying the Onondaga limestone
- Well-known fracture sets (J1 and J2)

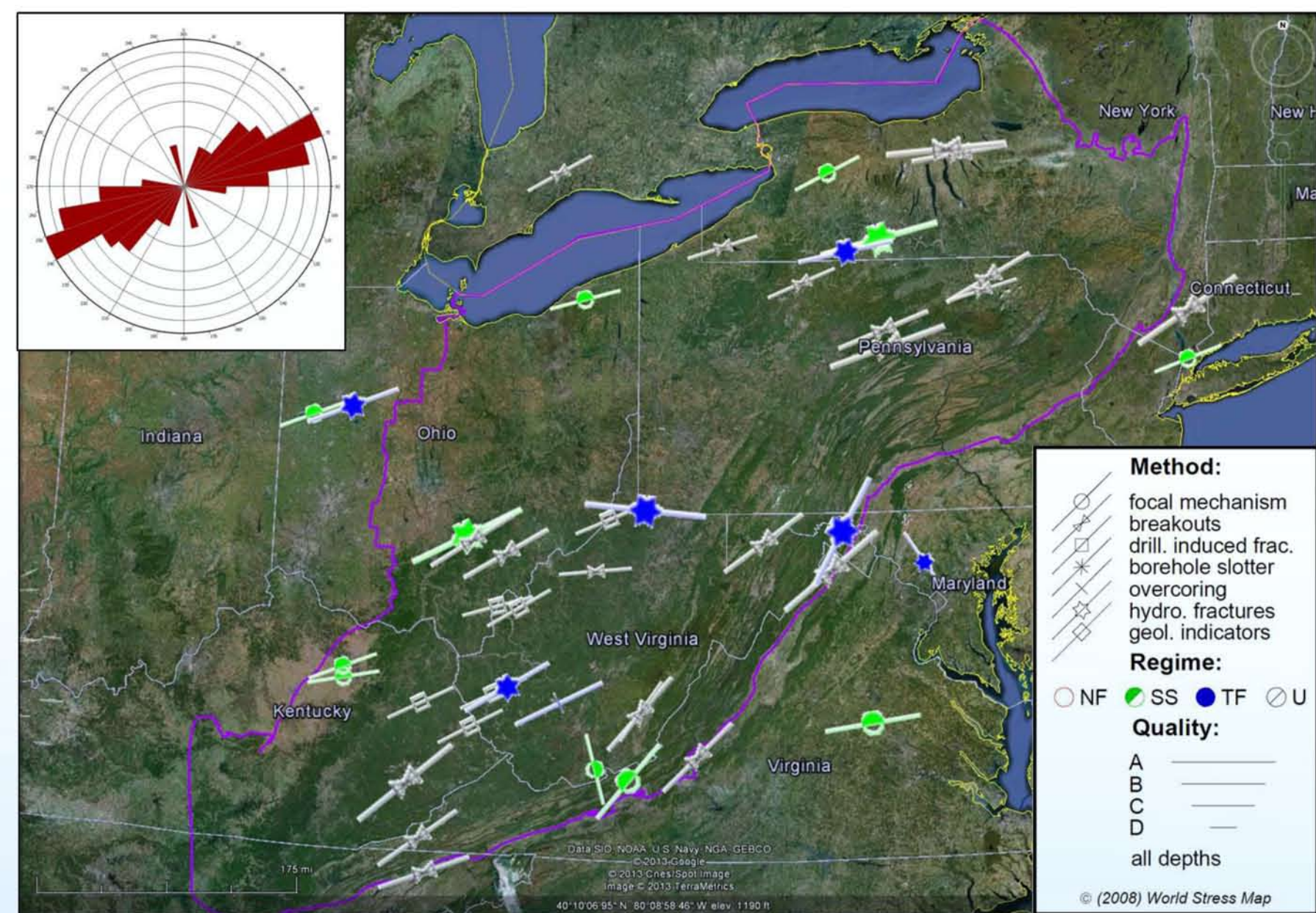


## METHODS

Data were collected from 11 counties in Pennsylvania, Ohio, and West Virginia. Surface-based and shallow buried geophone arrays were used. The wide azimuth, high fold, and large aperture of the arrays provide pickable first arrivals to solve for a focal mechanism. The strike of these mechanism is combined into a rose diagram for each formation and each state in the study area.

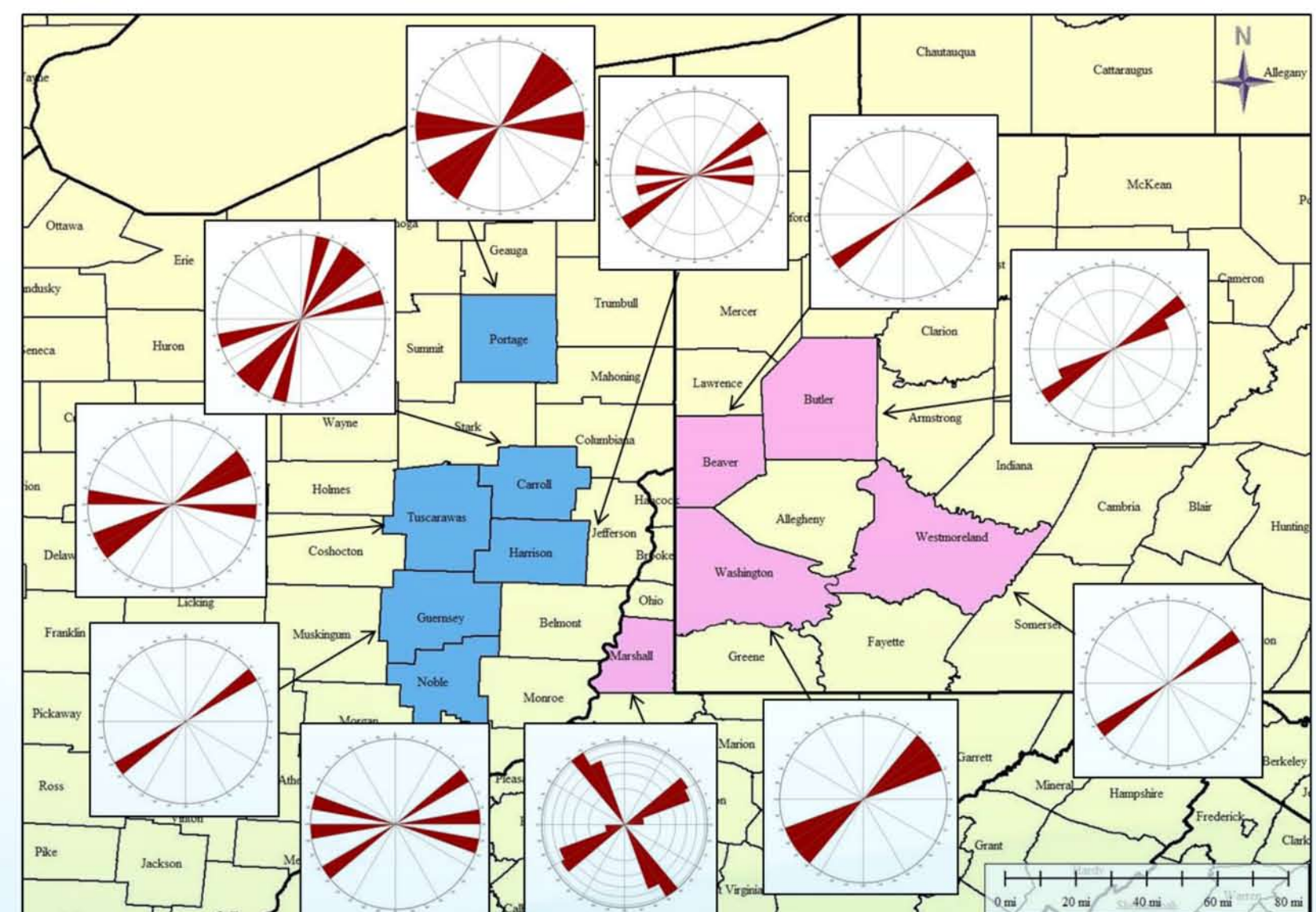
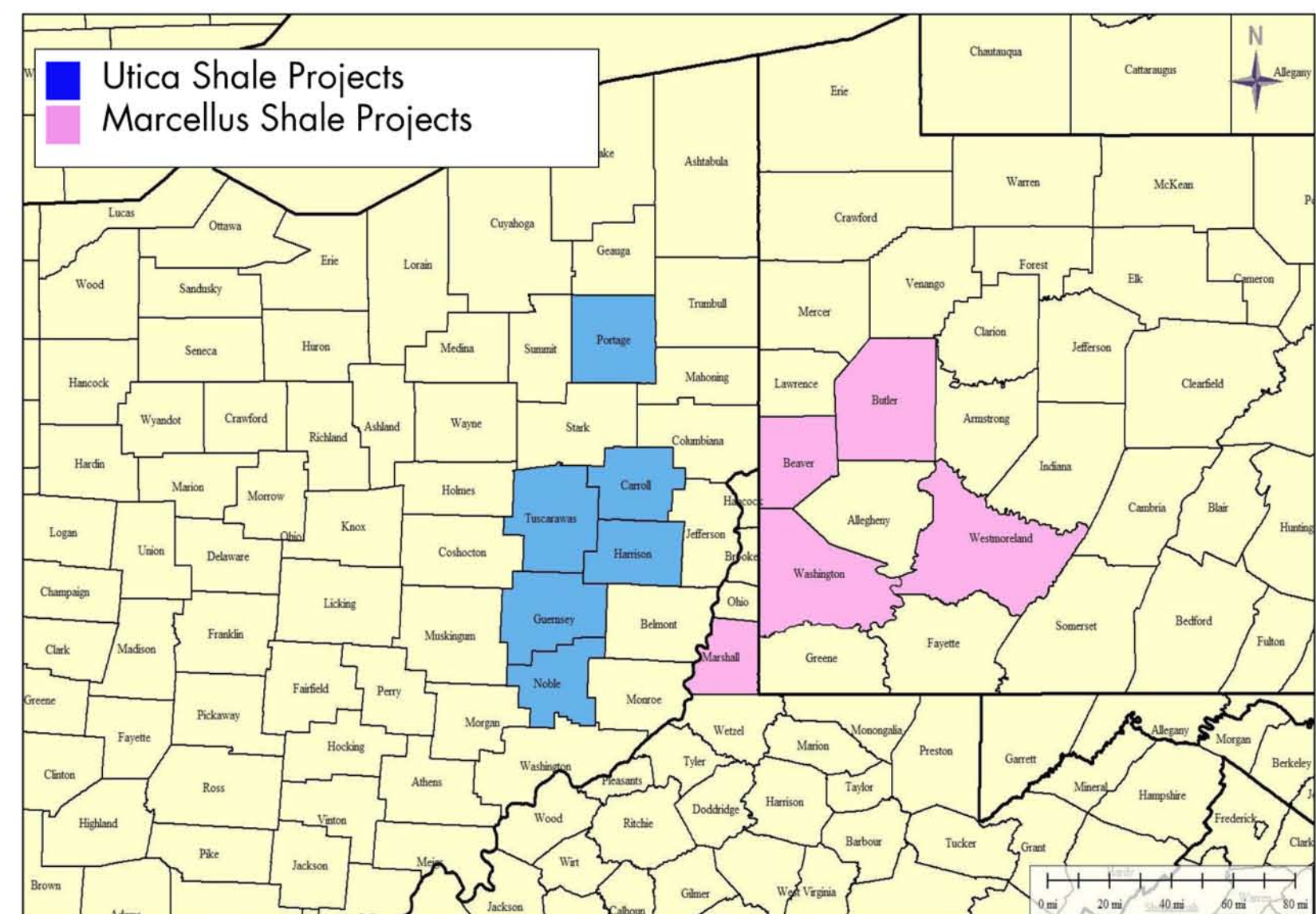


## WORLD STRESS MAP



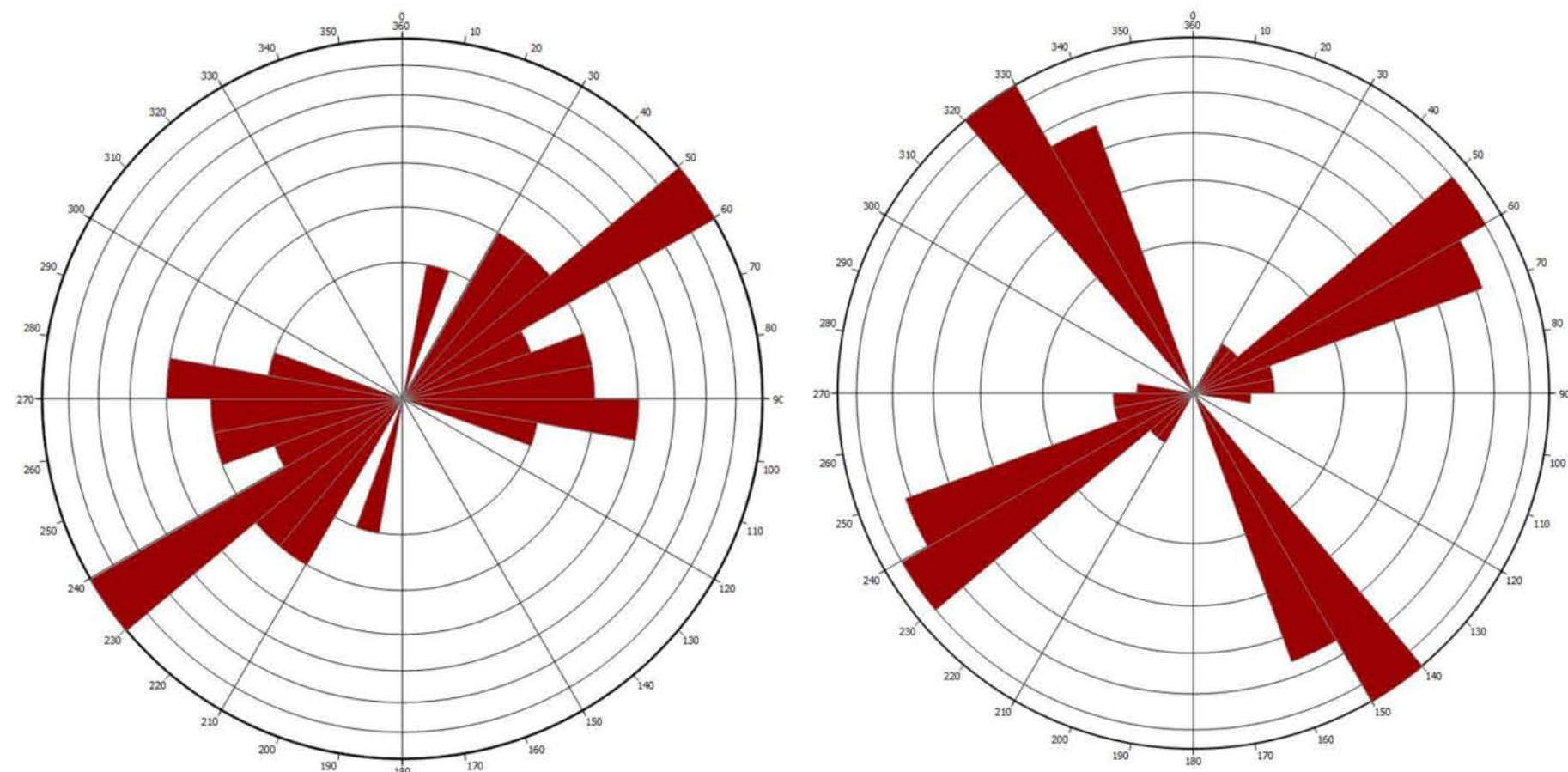
## DISCUSSION

Focal mechanisms in the Marcellus Shale (pink) indicate two dominant fracture orientations, northeast and northwest. These correspond to the known fracture sets in the Marcellus, J1 and J2. Focal mechanisms in the Utica Shale (blue) indicate a dominant northeast orientation and a secondary east orientation. The northeast orientation is similar to the J1 fracture set in the Marcellus, but the east orientation is not as common in the Marcellus. This might indicate that maximum horizontal stress at the time of natural hydraulic fracture formation in the Utica was approximately east.



## COMPARISON OF ORIENTATIONS

The rose diagram to the left indicates Utica Shale fracture orientations; the diagram on the right indicates Marcellus Shale fracture orientations.



## CONCLUSIONS

There is a common fracture trend in both shales oriented northeast. In the Marcellus, there is a known fracture set oriented northeast, named J1. A secondary fracture set in the Utica indicates approximately east orientations. This fracture set does not exist in the Marcellus.

The northeast orientation exists in both the Marcellus and Utica shales, indicating that these fracture sets formed during similar stress regimes. However, the east orientation in the Utica indicates that those fractures were formed during a different stress regime. As the Utica Shale becomes more profitable, fracture patterns and regional trends will become more evident.