pyGeoPressure: an Open-Source Package for Geopressure Prediction

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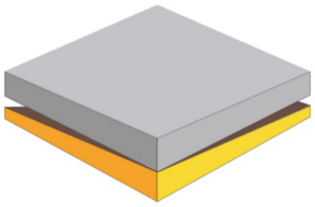
November 23, 2022

Abstract

Geopressure (or pore pressure) prediction is of central importance in both the exploration and development of hydrocarbon reservoirs. For pore fluid pressure affects the physical properties of reservoir rocks, predicted pressure is a key input when building the geomechanical model of a reservoir. Overpressure also influences the distribution of hydrocarbon, and sometimes can even work as an effective seal. Predrill pore pressure data in depth can help prevent geo-hazards like kicks, blowouts and drilling fluid infiltrating the formation whiling drilling in overpressured formations. pyGeoPressure provides a set of open-source tools to perform the geopressure prediction workflow which involves data preprocessing, parameter optimization, pressure prediction and quality control. Pore pressure can be predicted using well log data or seismic velocity data. Both of these two kinds of predictions are supported in pyGeoPressure. In addition to standard methods of Eaton's and Bowers', a new multivariate prediction method is also implemented in pyGeoPressure which incorporates petrophysical properties like porosity and shale volume other than sonic velocity. Another set of functionalities that pyGeoPressure provides are generating graphs. It can generate slices and sections of predicted pressure cube and well log predicted pressure profiles, both of which are of publication ready standard. pyGeoPressure is designed with flexibility and portability in mind. pyGeoPressure provides a flexible survey management system based on a clear folder structure, in which adding new well or seismic data cube can simply be achieved by adding a json file with required information. The basic numerical type used in computation under the hood is numpy array, so it can work together with scientific computation tools within python ecosystem. pyGeoPressure provides an open-source solution to geopressure prediction and a framework upon which researchers and engineers can quickly test and implement new prediction ideas. In this poster, we summarize the key components of pyGeoPressure and present a prediction workflow using data from East China Sea to showcase its functionalities.



pyGeoPressure

Geopressure Prediction in Python

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JOSS 10.21105/joss.00992

Introduction

Geopressure (or pore pressure) prediction is of central importance in both the exploration and development of hydrocarbon reservoirs. Pore fluid pressure affects the physical properties of reservoir rocks, hence predicted pressure is a key input when building the geomechanical model of a reservoir. Overpressure also influences the distribution of hydrocarbon, and sometimes can even work as an effective seal. Predrill pore pressure data in depth can help prevent geo-hazards like kicks, blowouts and drilling fluid infiltrating the formation whiling drilling in overpressured formations.

pyGeoPressure provides a set of open-source tools to perform geopressure prediction workflow which involves data preprocessing, parameter optimization, and pressure prediction.

Examples

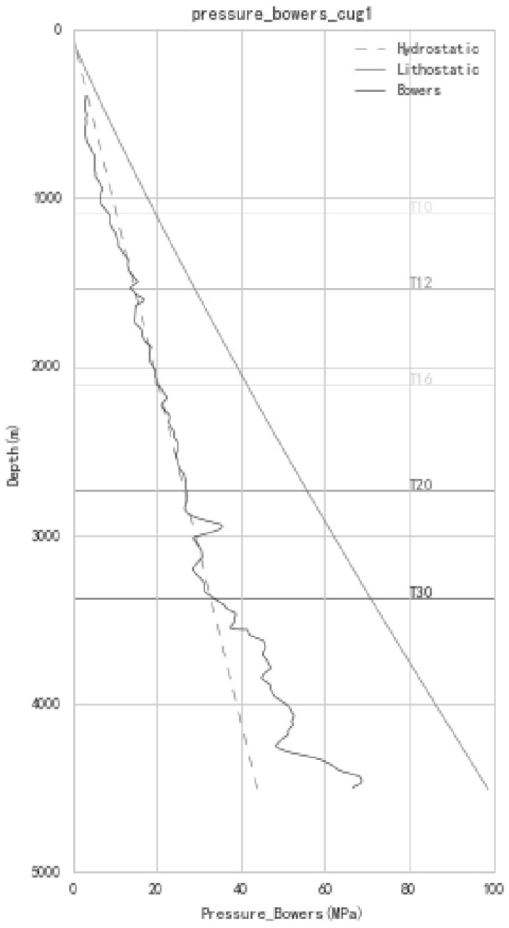

Fig 1. Pore Pressure Prediction with Bowers' method using well log velocity data.

Pore Pressure Prediction with Bowers' method using well log velocity data in *pyGeoPressure*:

```
import pygeopressure as ppp

survey = ppp.Survey("CUG")
well_cug1 = survey.wells['CUG1']

a, b, err = ppp.optimize_bowers_virgin(
    well=well_cug1,
    vel_log=vel_log_filter_smooth,
    obp_log='Overburden_Pressure',
    upper='T12', lower='T20',
    pres_log='loading', mode='both')

u = ppp.optimize_bowers_unloading(
    well=well_cug1,
    vel_log=vel_log_filter_smooth,
    obp_log='Overburden_Pressure',
    a=a, b=b, vmax=4600,
    pres_log='unloading')

pres_log = well_cug1.bowers(
    vel_log=vel_log_filter_smooth,
    a=a, b=b, u=u)
```

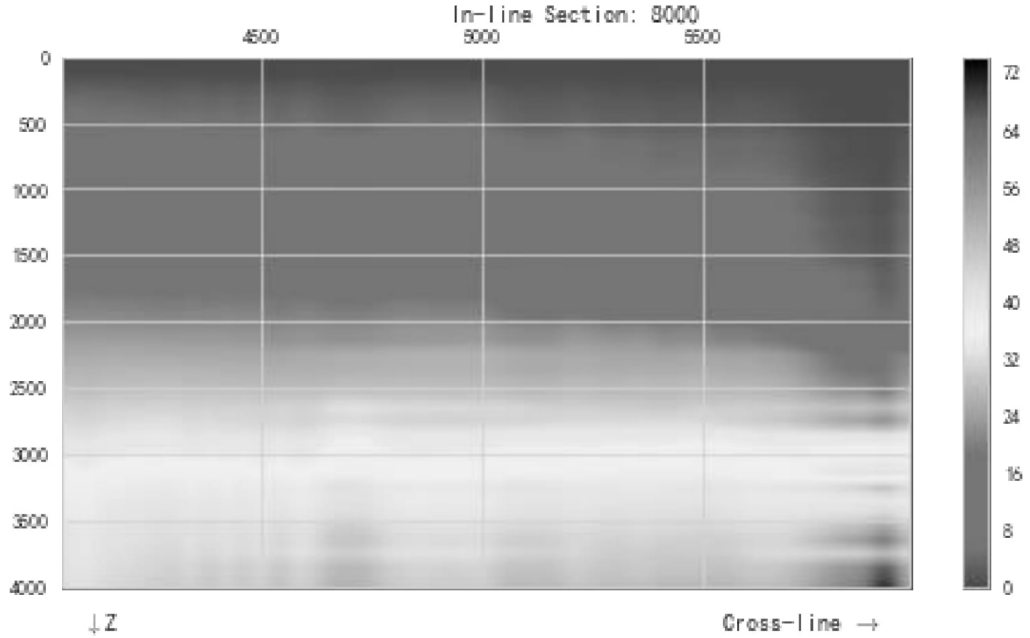

Fig 2. Pore Pressure Prediction with Bowers' method using seismic velocity data.

Features

Pore pressure can be predicted using well log data or seismic velocity data. Both of these two kinds of predictions are implemented in *pyGeoPressure*.
In addition to standard methods of Eaton's[1]and Bowers'[2] a new multivariate prediction model[3] is also implemented in *pyGeoPressure* which incorporates petrophysical properties like porosity and shale volume other than sonic velocity. Another set of functionalities that *pyGeoPressure* provides are generating graphs. It can generate slices and sections of predicted pressure cube and well log predicted pressure profiles.

Methods implemented:

1. Eaton's method and Parameter Optimization
2. Bowers' method and Parameter Optimization
3. Multivariate method and Parameter Optimization

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Conclusion

pyGeoPressure is designed with flexibility and portability in mind. *pyGeoPressure* provides a flexible survey management system based on a clear folder structure, in which adding new well or seismic data cube can simply be achieved by adding a json file with required information. The basic numerical type used in computation under the hood is NumPy array, so it can work together with scientific computation tools within python ecosystem. *pyGeoPressure* provides a simple, easily accessed open-source solution to geopressure prediction and a framework upon which researchers and engineers can quickly test and implement new prediction ideas.

Project Repo on Github:

References

1. Eaton, B. A., & others. (1975). The equation for geopressure prediction from well logs. In Fall meeting of the society of petroleum engineers of AIME. Society of Petroleum Engineers. doi:10.2118/5544-MS
2. Bowers, G. L., & others. (1995). Pore pressure estimation from velocity data: Accounting for overpressure mechanisms besides undercompaction. SPE Drilling & Completion, 10(02), 89–95. doi:10.2118/27488-PA
3. Sayers, C., Smit, T., Eden, C. van, Wervelman, R., Bachmann, B., Fitts, T., Bingham, J., et al. (2003). Use of reflection tomography to predict pore pressure in overpressured reservoir sands. In Submitted for presentation at the SEG 2003 annual meeting. doi:10.1190/1.1817541