Using ArcGIS to evaluate potential hydrocarbon resource

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Outline

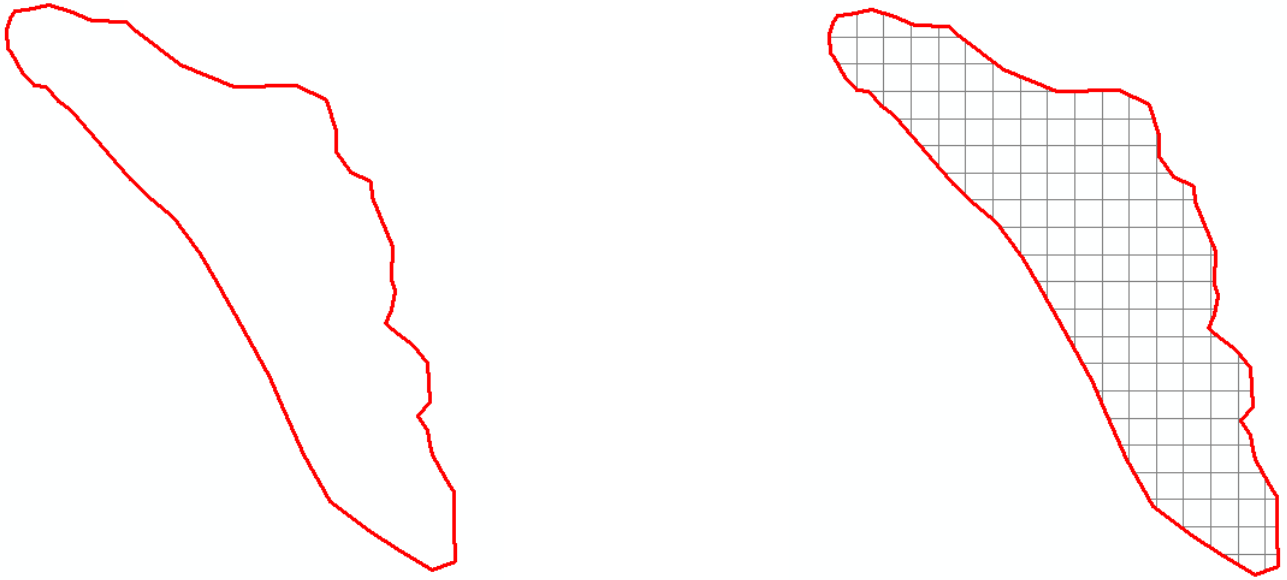
- Methodology
- ArcGIS tool and service
- case study
- Conclusion

Improvement of the Volume method

Volume method is widely used for oil and gas resources assessment

Volume method formula for heavy oil:

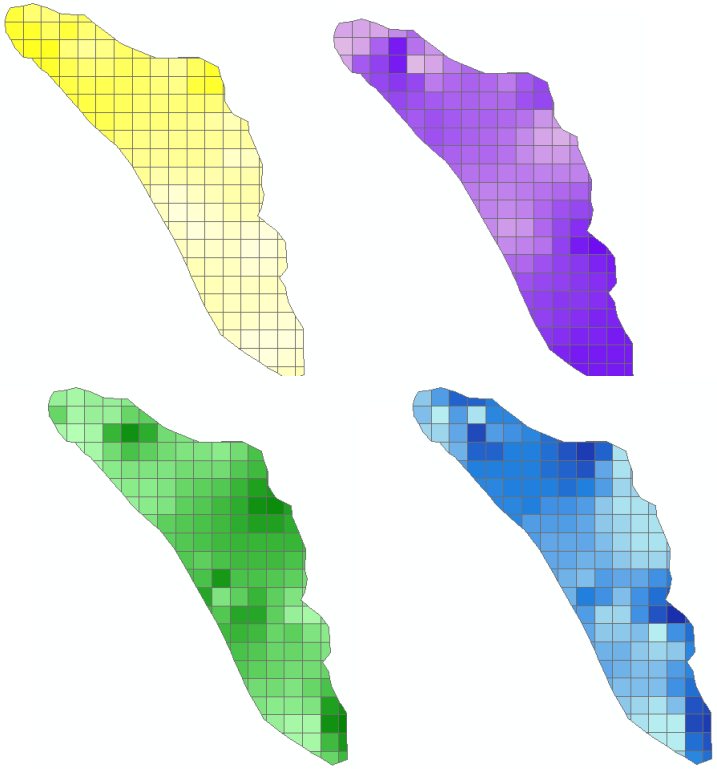
$$GIP = A \times h \times \Phi \times \mathrm{S}_{oi} \times \rho_o / \mathrm{B}_{oi} \times cf$$



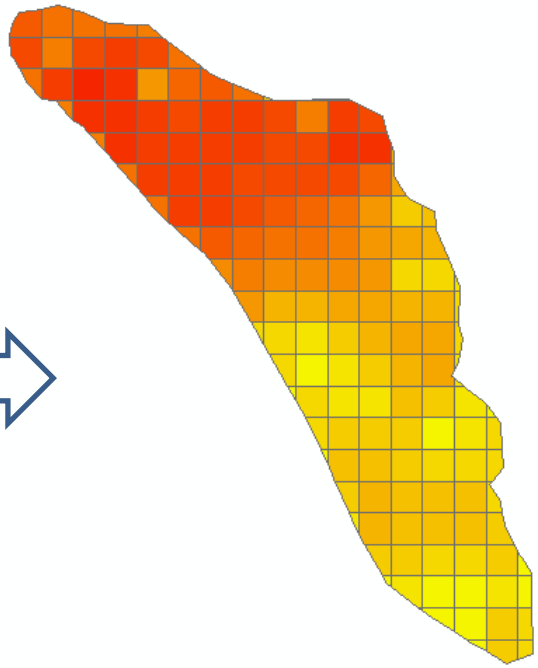
Dividing the evaluation area into grids

Volume method based on grid

- Interpolation is used to get the parameters for each grid
- The resources for each grid is calculated by volume method
- The sum of the resources of each grid is the total resource of the assessment area.



Paremeters for each grid



Resources for each grid

Evaluation process

Geological analysis	dividing the area into evaluation units
Collecting data	collecting data such as contour lines, well logging , geophysical exploration etc.
Grids division	dividing evaluation area into grid
Interpolation	getting the parameters of each grid by interpolation algorithm
Calculating	calculating resources for each grid by volume method
sum up	sum up each grid's resources

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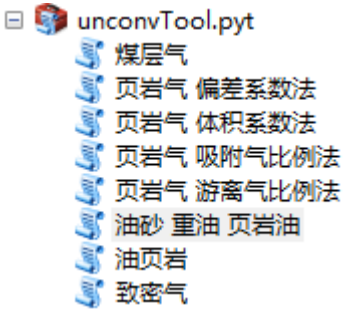
ArcGIS Desktop Tool

- A python toolbox is created
- according to the different volume formula, eight python script tools are developed.
- using the ArcPy Library
- tools can run in ArcGIS desktop



ArcGIS Desktop Tool

Input and Output : take heavy oil as an example

Input
number of grids in a certain direction
spatial data of oil area
Thickness(Shape file or value)
porosity(Shape file or value)
Oil saturation(Shape file or value)
recovery (Shape file or value)
Volume factor
result output position

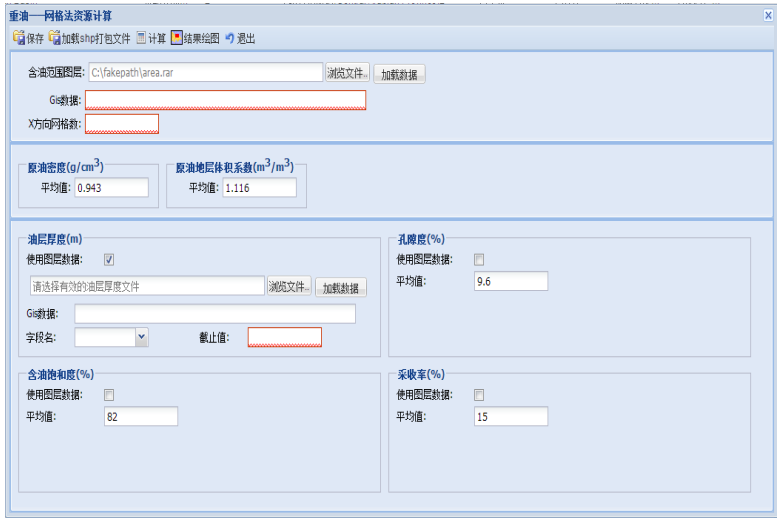
Output
return state
geological resources
Recoverable resources
Result spatial data (shpfile)

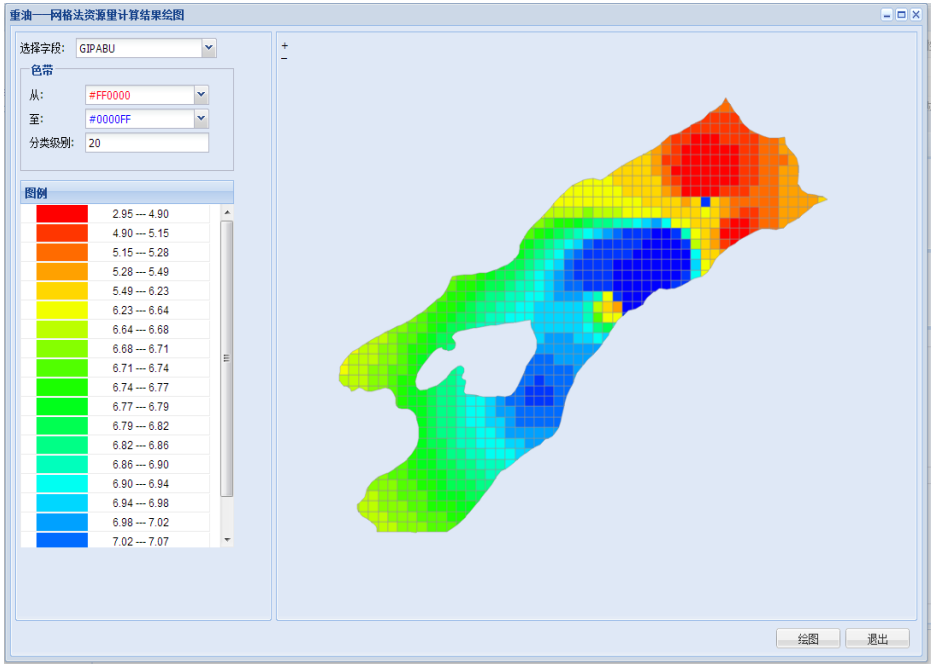
Calculating procedures

	Procedure	Used ArcGIS tools	Input	output
1	Data Verification	Project	Shape files	Projected Shape files
2	Grids division	Create fishnet Clip	Evaluation area shape file and number of grids	Fishnet shapefile
3	Interpolation	IDW_interpolation GAlayerToPoints TopoContour TopoToRaster …	Fishnet shapefile	Parameter values for each grid
4	Calculation	CalculateField	Parameter values for each grid	Resource values for each grid
5	Sum up		Resource values for each grid	Total resources

ArcGIS Server GP Service

- the python tool is published as a GP service in ArcGIS Server
- GP service can be used in CNPC intranet





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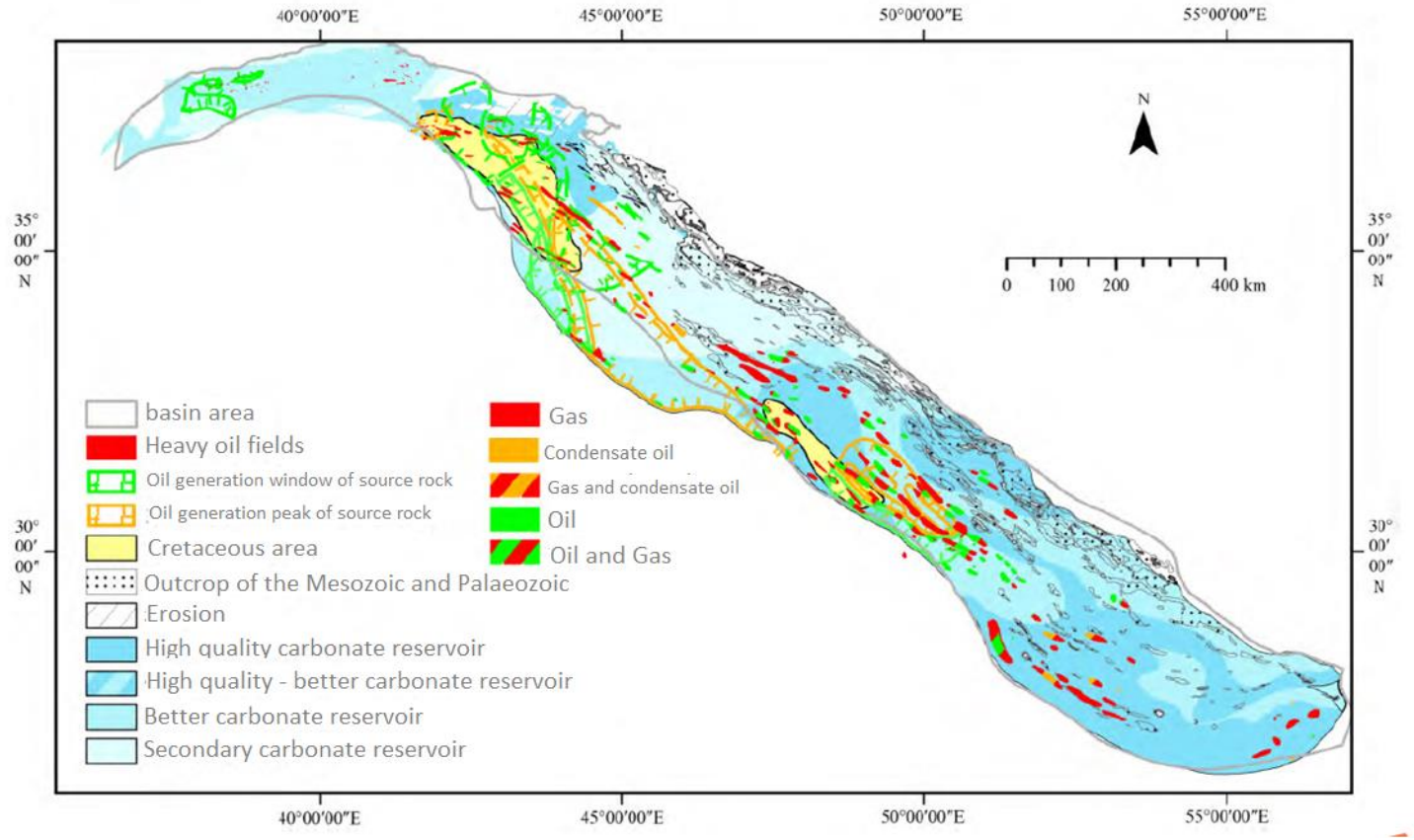
Case Study

ArcGIS Desktop Tool was used to evaluate the potential of heavy oil in the Zagros fold belt in Middle East.



Play Division

Zagros fold belt is divided into 4 plays: Triassic Jurassic Butmah play, Jurassic play, Cretaceous play, and Tertiary

Play	Trap Type	Cap Rock	Source Rock	Reservoir
Triassic Jurassic Butmah	Anticline, broken block	Lower and Middle Jurassic evaporite	shallow sea facies deposit	Limestone and dolomite
Jurassic	Anticline	Upper Jurassic evaporite and interlayer shale	Clay plaster rock	Middle and Upper Jurassic carbonate
Cretaceous	Anticline, broken block	mud shale	Jurassic and Cretaceous shale	Mainly Cretaceous limestone
Tertiary	Anticline, broken block	Evaporite	Lower Cretaceous Jurassic shale	Third series of limestone and sandstone

Data Collection and Processing

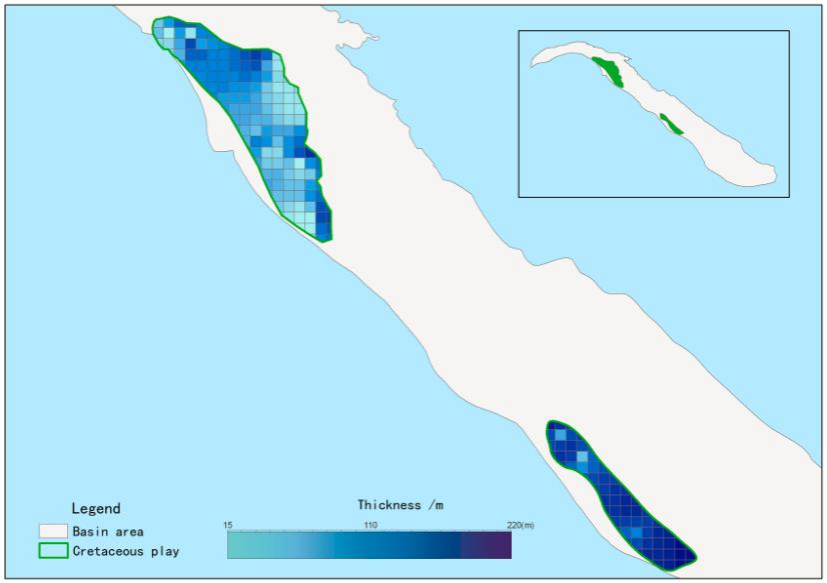
data sources

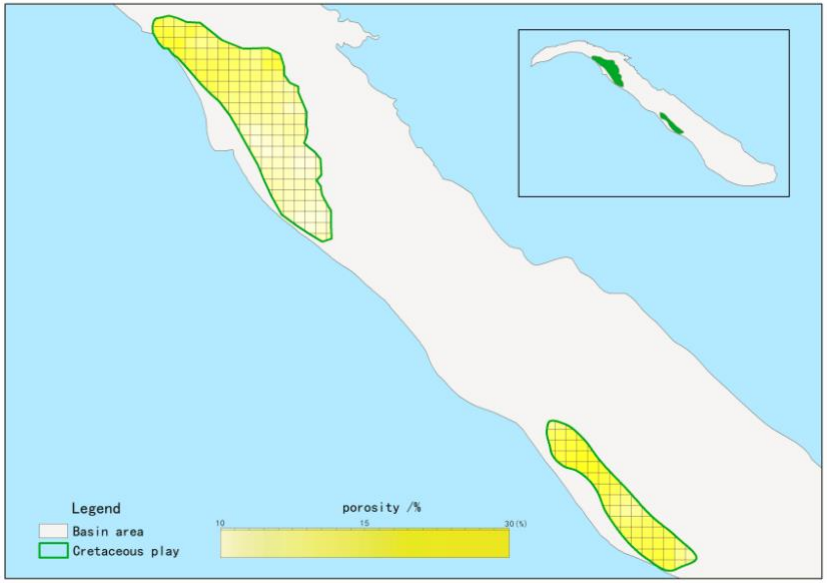
- Existing research data, such as reports, maps
- geophysical exploration
- well logging
- core analysis
- The historical production data of the development well

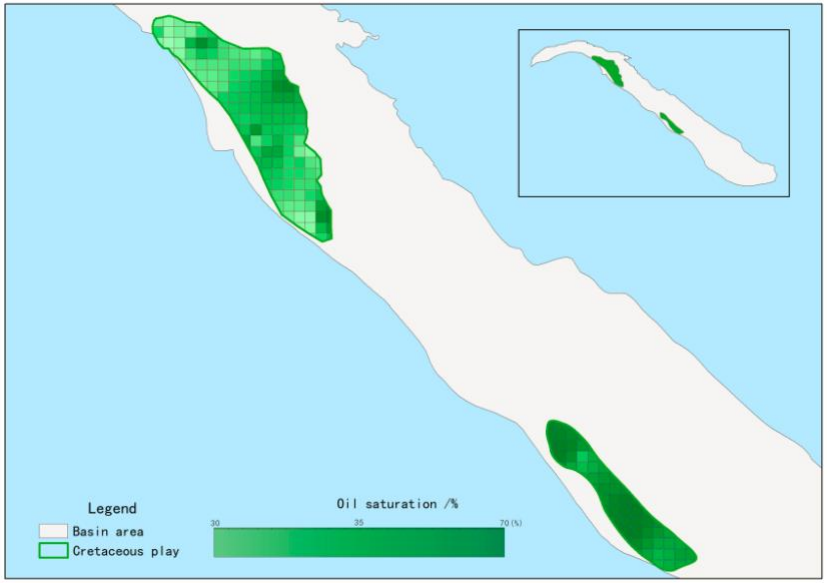
Data Collection and Processing

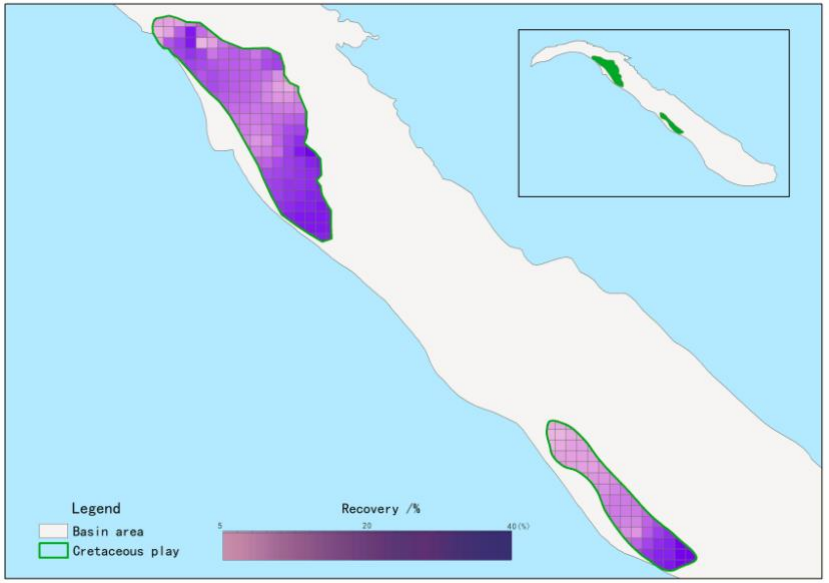
Parameter	Type	Source	Processing
spatial data of oil area	Shape file	Existing maps	Data format conversion
Thickness	Shape file	Existing contour maps	map digitizing
porosity	Shape file	Well logging	Create shape file and input data
Oil saturation	Shape file	Well logging	Create shape file and input data
recovery	Shape file	Development wells	Create shape file and input data

Parameter Interpolation Maps

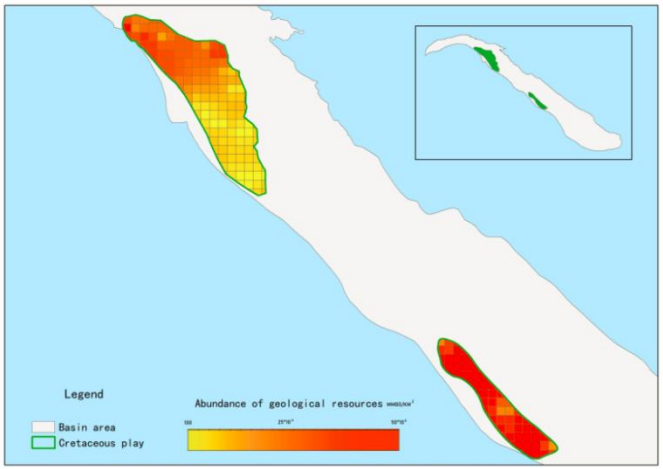








Geological and recoverable resources Maps



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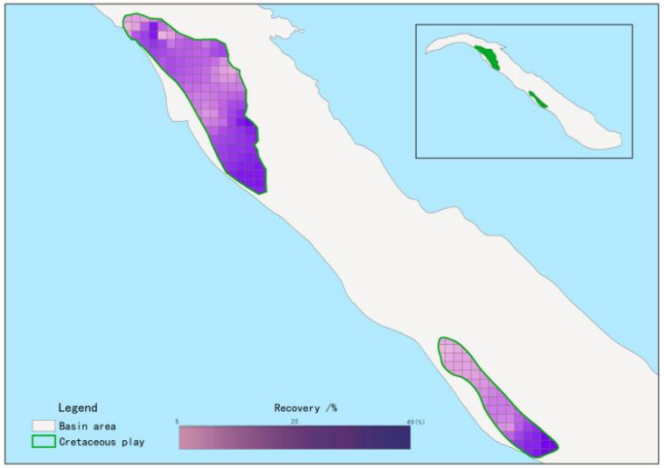

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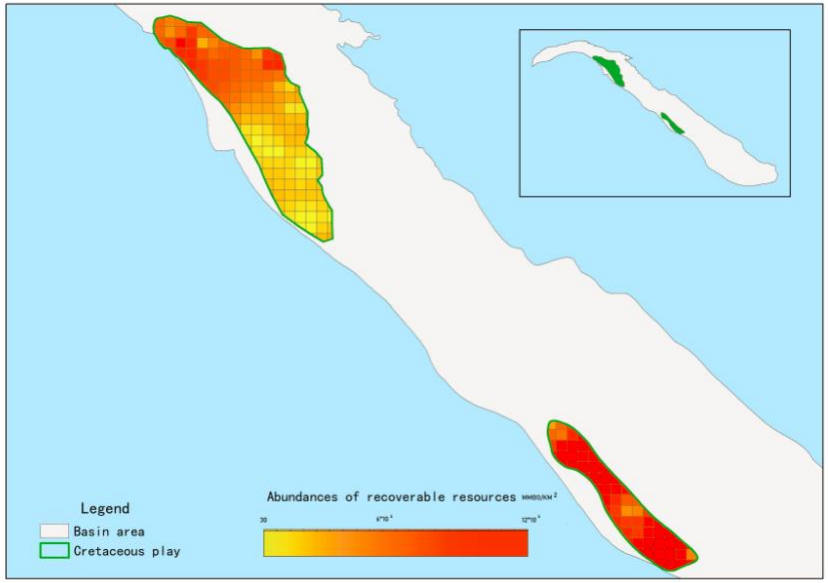

The evaluation results

- The total geological resources of Zagros fold belt are * billion T
- The total recoverable resources are * billion T.
- Cretaceous is the most favorable reservoir combination
- Heavy oil resources are mainly concentrated in the midwest of the Zagros fold belt.

Conclusion

1. The improved volume method can evaluate resources more accurately, and also show the geographical distribution of potential hydrocarbon.
2. This feature makes it more suitable for the evaluation of unconventional oil and gas with "continuous aggregate distribution" characteristics.
3. geological knowledge and geological parameters are the key to the accuracy of the evaluation results.
4. ArcGIS is a good tool for the implementation of the method, not only for calculation, but also for mapping.
5. The tool has been used in the evaluation of unconventional oil and gas resources in last 3 years and applied effectively.

Questions?

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