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Study and Application of Reservoir Prediction Technology in Block S in Sulige Gas Field, Ordos Basin

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Abstract. Block S of the sulige gas field has achieved 800 million cubic meters of natural gas production capacity, and has been producing steadily for eight years. However, some problems were exposed during the development of the blocks, such as rapid change of sedimentary facies, rolling development to the boundary of favorable and rich areas, potential evaluation of blank areas and so on. Due to the limitation of seismic quality, early conventional data processing, AVO prediction and other technical limitations in block S, the accuracy of reservoir distribution and gas content prediction results is low. At present, it is impossible to effectively implement the boundary range of gas and evaluate the resource potential of the blank areas. Through the processing of seismic data in block S, the most suitable gas-bearing prediction method is optimized to increase the coincidence rate of seismic prediction. Application results show that: compared with the original data, the newly processed and interpreted 3D seismic data are more consistent with the real drilling, which can greatly improve the effective drilling encounter rate of class I well.

Keywords: 3D seismic data · Fine structure and fault interpretation · Gas drilling encounter rate · Well location deployment

1 The Introduction

Reservoir and gas-bearing prediction technology: Reservoir prediction technology at home and abroad is developing rapidly. At the same time, with the continuous advancement and development of the computer hardware industry, the past single method research has extended to the current comprehensive prediction of various methods [1]; especially in recent years. The rapid development of a variety of new technologies in the year provides an important basis for the development of reservoir prediction, accurate well location deployment and the completion of reserve tasks. The addition of new technologies and new methods has continuously improved the quality of seismic data. The use of well control frequency-raising, OVT technology to re-process seismic data, improve deep resolution, further enrich low-frequency information, is conducive to reservoir and oil and gas prediction; use seismic waveform indication inversion method to predict sand body distribution characteristics, the

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method Strong deterministic, multi-parameter simulation through well-seismic seismic can effectively improve vertical and horizontal resolution, suitable for non-uniform wells, using porosity inversion and pre-stack inversion method for reservoir physical property prediction, characterizing high-quality reservoir distribution [2], can achieve better results in reservoir prediction.

2 Seismic Data Processing and Interpretation in Block S

According to the processing and interpretation results of seismic data in the northern and southern regions of block S, faults in the southern region are relatively developed, the geological conditions are complex, and the control effect of faults and micro-structures on gas reservoirs is not clear. At the same time, due to the poor quality of the data, the conclusion of reservoir prediction is not consistent with the real drilling data, and the 3Dseismic data does not effectively guide the production, construction and deployment of the south area. And north district under the influence of 2D seismic data quality, although the extension frequency processing and inversion prediction, but the prediction coincides with the real drilling data degree is not high, gas-bearing sand body distribution range is not clear, hindered the further development of north district evaluation, aiming at these problems, is an urgent need to carry out seismic data processing and interpretation, reservoir hydrocarbon content and fracture prediction technology research, on the basis of fidelity, by increasing the resolution of seismic data, the fine structure modeling, strengthen reservoir and hydrocarbon prediction precision and attribute modeling, late to block out the controlling factors, optimizing gas, Lay the foundation for the implementation of favorable production and construction target areas.

2.1 Chromatography Static Correction

By applying tomographic static correction, the influence of the elevation and low velocity reduction on the data is eliminated, and the quality of the profile is significantly improved (see Fig. 1).

2.2 Prestack Integrated Fidelity Denoising

Through the denoising process, several high-energy interferences that have the most serious impact on the quality of seismic data are removed, the effective wave components are relatively enhanced, and the overall signal-to-noise ratio of the profile is greatly improved (see Fig. 2).

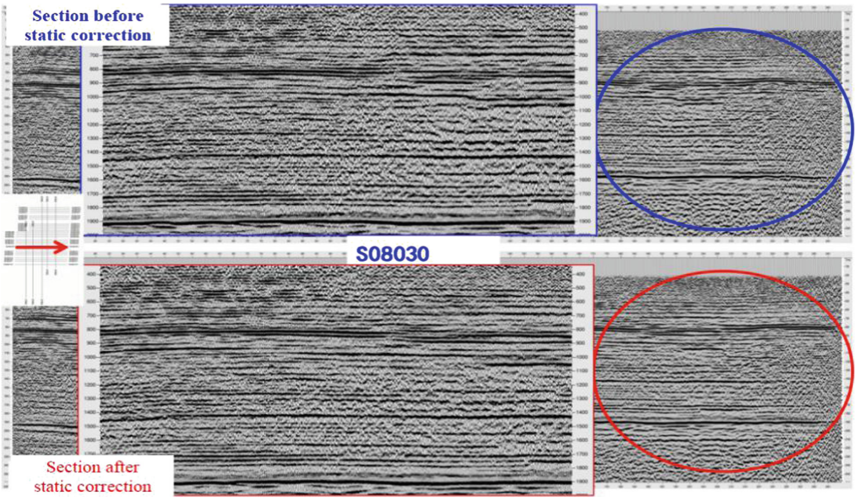

Fig. 1. The before and after correlation section of residual static correction.

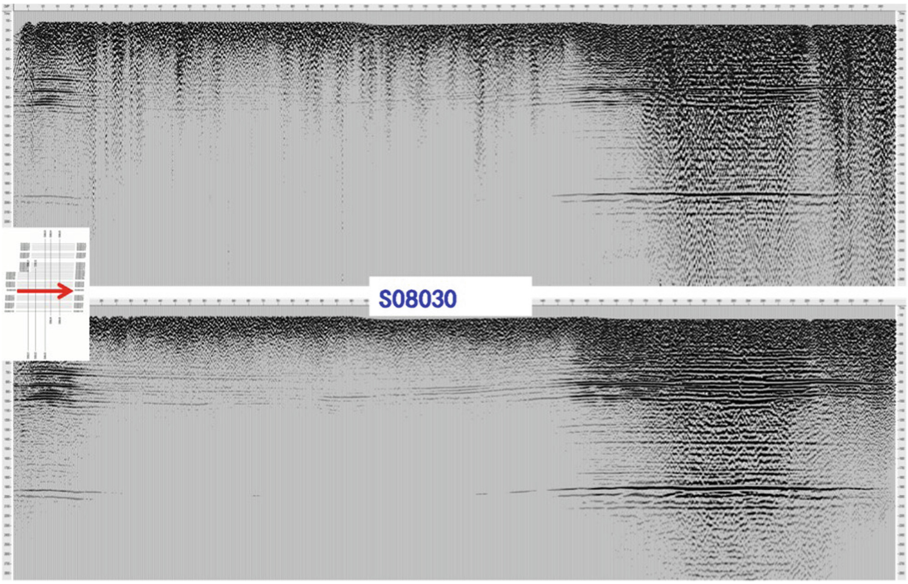

Fig. 2. Section comparison before and after fidelity amplitude denoising.

2.3 Well Control Frequency

Through the display and comparison of the processed data, it can be seen that the newly processed two-dimensional line and the newly processed three-dimensional data are consistent in wave group and morphology. Compared with the old data, the newly processed seismic data wave group features are good, and the signal-to-noise ratio is good. Moderately, the frequency band range is increased to 5–45 Hz (see Fig. 3 and Fig. 4).

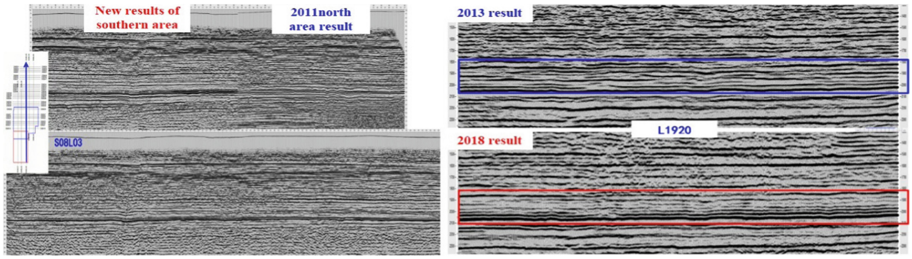

Fig. 3. Comparison of the three-dimensional profile of the new and old results.

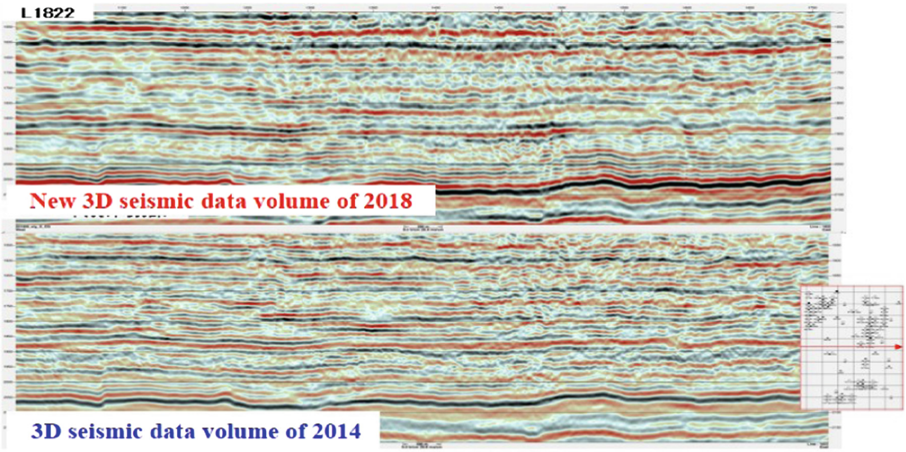

Fig. 4. The section of the 1882 line of the data line of 3D seismic results in 2018 and 2014 is compared.

2.4 OVT Prestack Migration

The OVT offset effect is higher than that of the conventional prestack time shift processing, and the inter-layer information is rich (see Fig. 5).

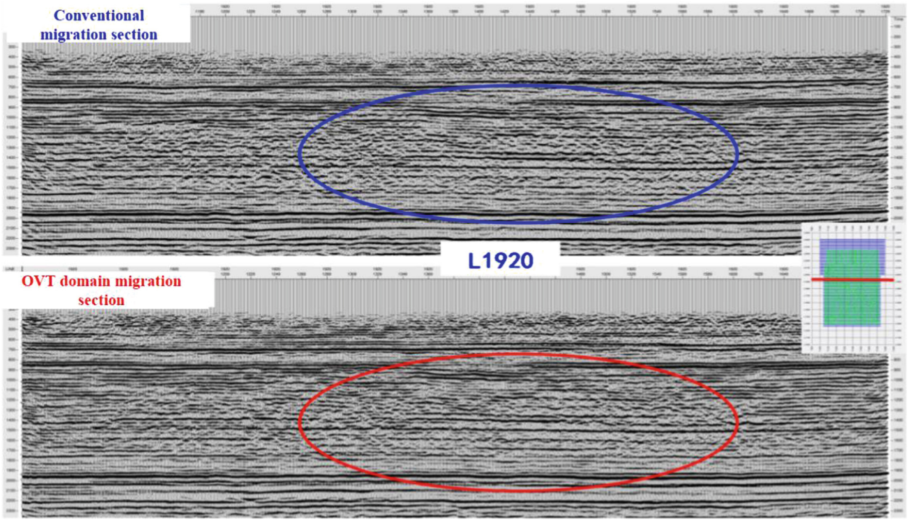

Fig. 5. Conventional migration section and OVT domain migration section-L1920

2.5 Sand Body Prediction Under the Constraint of Geological Model

Similar sedimentary environments have similar curved cycle characteristics (combined structure). Similar composite structures will produce similar seismic waveforms. The lateral variation of seismic waveforms can indicate the classification of reservoir structures. The similar waveforms represent the reservoir structure. Comparable, through the waveform characteristics of high-yield wells, through waveform comparison, selecting selected samples based on waveform similarity for prediction can effectively improve the accuracy of earthquake prediction [3] (see Fig. 6).

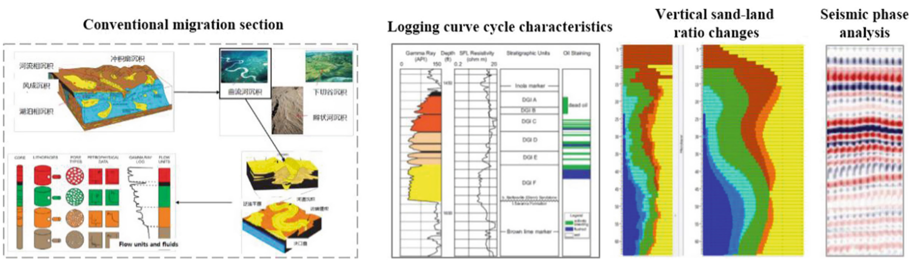

Fig. 6. Geological model constraint process

3 Application Effect

3.1 The Overall Structural Structure and Fracture Characteristics Are Clearer

The regional tectonic features and previous studies have shown that the fractures in the work area are not developed, but through the fine interpretation of the three-dimensional seismic data, it is found that the faults and twists of the same axis are very developed, confirming that the small, micro-faults and cracks in the southern part of S are very developed: A near EW fault is developed in the middle of the southern part (see Fig. 7). The plane extends for a long time and runs through the work area. The area is 9.5 m long and is broken up to the Shiqianfeng stratum. The fault distance is large. The fault is developed after the deposition of the Shiqianfeng stratum. It is the largest south-tipping fault in the work area. A series of faults develop in the west of the work area and move toward the NEE direction. A series of small faults with short extensions and small faults and NE-oriented faults are developed in the southern and northeastern parts (see Fig. 8). The structural features are more obvious, and the local development of the micro-nose structure is more obvious.

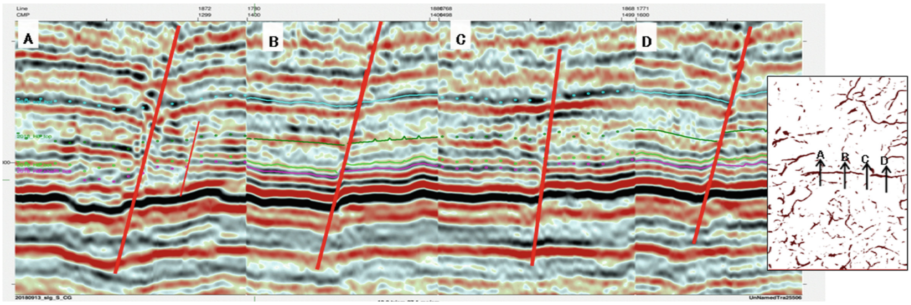

Fig. 7. Characteristics of large fault profiles

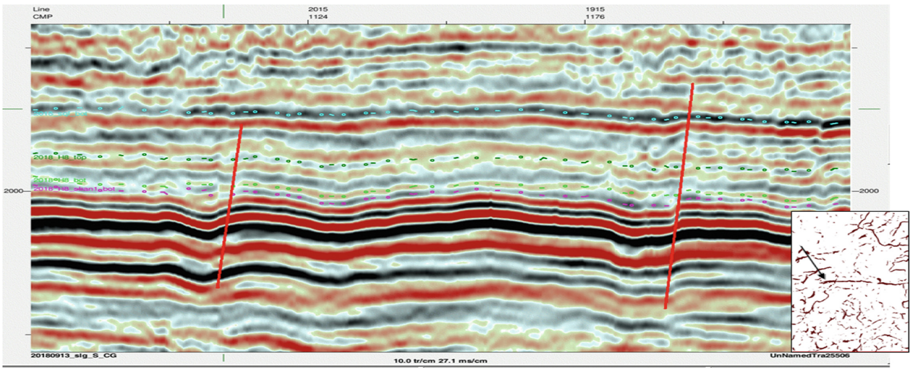

Fig. 8. Features of a small vertical fault section

3.2 Accurate Implementation of Regional Micro-structures and Micro-fractures to Provide a Basis for Gas Reservoir Boundary Division

Through fine structure interpretation and implementation of micro-structures, the three areas of S block were dissected respectively, namely S-A well area, S-B well area and S-C well area. Through analysis, it was found that the wells were put into operation at the same time in the same gas reservoir unit. The gas production and cumulative gas production of the gas wells at the high structure are higher than those of the gas wells at the bottom, which provides a basis for the deployment of well locations in the high structure. (see Fig. 9 and Table 1).

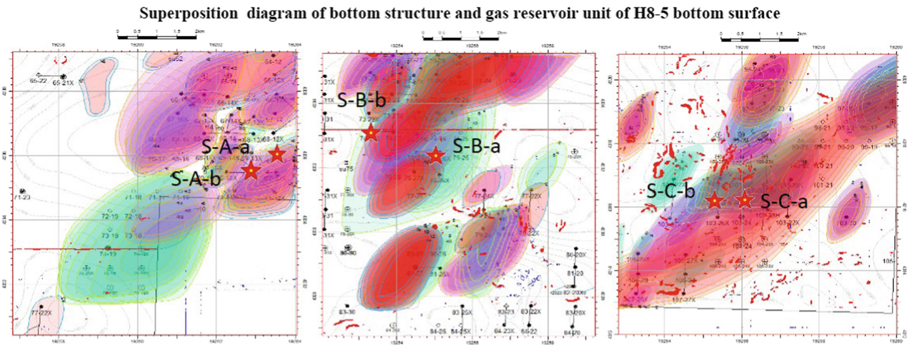

Fig. 9. Well area gas reservoir unit map

Table 1. Comparison of gas content and production data of gas wells in different structural parts of the same gas reservoir unit.

Well area	Well name	Structural high (m)	Gas layer thickness (m)	Gas saturation (%)	Commissioning data	Production horizon	Initial stage of production		Current production		Cumulative production (10^4m^3)
							Casing pressure (MPa)	Gas production (10^4m^3)	Casing pressure (MPa)	Gas production (10^4m^3)	
S-A	S-A-a	-1945	12.7	72.93	2010/11/1	H8、S1	21.77	2.8488	8.48	0.3134	3773.269
	S-A-b	-1962	5.8	68.22	2010/12/26	S1	22.17	1.6782	7.79	0.0302	2524.211
S-B	S-B-a	-2000	19.2	68.59	2016/12/10	S1	22.67	2.464	17.35	1.739	1688.352
	S-B-b	-2013	6.8	64.82	2016/7/21	H8、S1	4.89	0.2352	3.51	0.1404	212.7627
S-C	S-C-a	-2030	19.4	71.11	2010/12/11	H8、S1	22.91	3.066	1.87	2.6773	5118.95
	S-C-b	-2049	13.2	60.37	2010/12/2	H8、S1、S2	/	1.3054	3.44	0.5631	1838.214

3.3 The Portrayal of the Reservoir is More Precise and Accurate, Effectively Guiding Well Location Deployment

Through the fine characterization of the reservoir, combined with this year's actual drilling S-D well group as an example, combined with the analysis and analysis of the effective sand body, the analysis of the main layer gas reservoir unit in the S-D well area, Shanxi group gas The layer is not developed, the gas layer of H8-4 in the lower sub-section of Box 8 is not developed, and the segment of Box 8-5 has a certain range of distribution in the north-south direction. Comprehensive analysis shows that there are long sedimentary discontinuities in the H8 segment of the S-D well and the Shanxi group. At the same time, due to the frequent migration of the river channel, the physical properties of the reservoir change rapidly, and the area of the heart beach development area is small. Although the production of the S-D-a well in the southeast side is relatively good, it is based on the comprehensive prediction and the degree of gas layer development (see Fig. 10). The surrounding adjacent wells do not belong to the same sedimentary facies belt. From the river course and attribute prediction results, the gas layer of the H7 section of the S-D-b well in the adjacent well is not developed at the well. The formation of the gas layer is mainly H8–5, and the north S-D-c well can continue to drill. The S-D-d well on the east side is at greater risk and is not recommended.

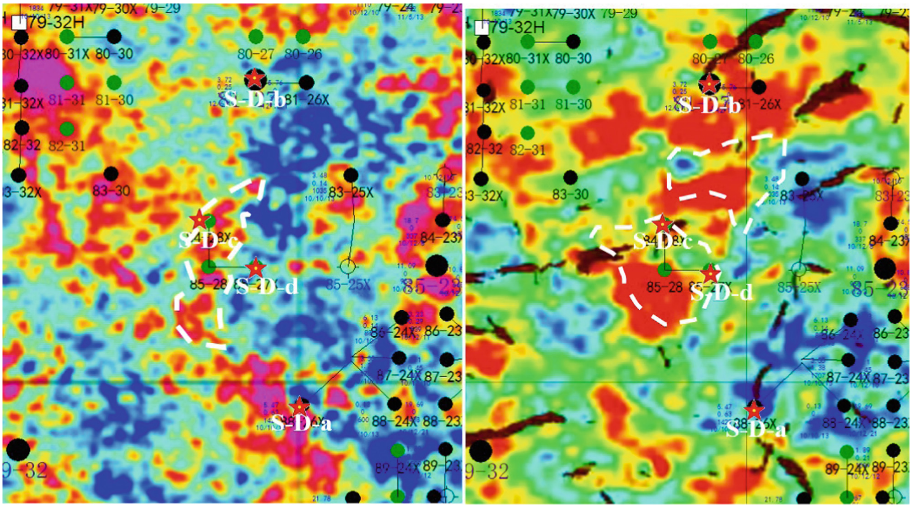

Fig. 10. H8 lower sub-Poisson's ratio property prediction map, S1 segment Poisson's ratio and curvature property prediction map

3.4 Effectively Predict the Distribution Characteristics of Source Rocks and Indicate the Direction for Further Evaluation of Blocks

Through investigation of a large number of regional data analysis [4], the distribution relationship between source rock and sand body affects gas saturation, hydrocarbon source rock has high capacity for filling, high gas drainage capacity, natural gas enrichment, hydrocarbon In the low-value area of source rock maturity, the hydrocarbon filling ability is weak, the gas drainage effect is weak, the formation water is developed, the hydrocarbon filling is medium, and the gas drainage effect is not complete (Fig. 11).

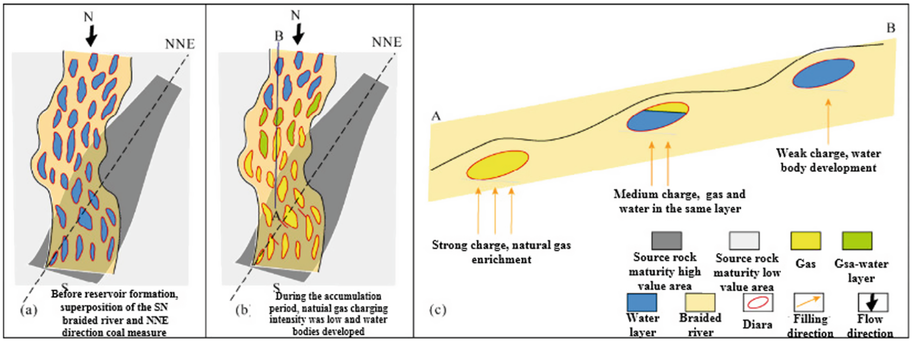

Fig. 11. Pattern of evolution of gas and water distribution in the western area of Sulige

According to the arrangement relationship between source rock and sand body, the coal seam thickness of Taiyuan Formation in the southern area is predicted. By superimposing with the fault system, the area with large coal seam thickness is predicted as the key direction of the next evaluation and development in the fault development area [5].

4 Effect Evaluation

Through comprehensive geological research, reservoir prediction, fine gas reservoir unit division, well location deployment, 35 well locations were proposed.

According to the analysis of 31 wells drilled in S block, 27 static Class I wells, 10 wells with gas layer thickness greater than 20 m, 3 Class II wells, 1 Class III well, average single well gas layer The thickness is 16 m, which is higher than the average of the previous years (12.7 m). The single-layer gas layer of the S-E well reaches 14.4 m, and the I + II ratio reaches 96.7%. The results of the cluster drilling show that the new treatment explains the three-dimensional earthquake significant. The gas layer drilling rate is increased, especially the gas layer drilling ratio of the class I well can be greatly increased.

5 Conclusion

(1) Effective use of five key technologies, such as chromatography static correction, prestack integrated fidelity denoising, well control frequency technology, OVT prestack migration technology, and sand body prediction under the constraint of geological model, to make seismic data Quality and prediction accuracy are significantly improved.

(2) Through the reservoir inversion based on geological model constraints, the portrayal of the reservoir is more precise and accurate, effectively guiding the well location deployment and dynamic analysis while drilling.

(3) Through reservoir and fracture prediction, sedimentary facies and gas reservoir unit matching, the reservoir sweet zone and fault development zone are further clarified, which provides a basis for further evaluation.
(4) The cluster drilling results show that the new 3D seismic data of the S block effectively guides the well location deployment, significantly improves the gas layer drilling rate of the cluster wells, thereby further improving the overall development benefit of the gas field and ensuring the S area continues to produce stable production.

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