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NEW CLASSIFICATION MODEL BASED ON COMPLICATION EXTENTS OF STRUCTURES

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A b s t r a c t

This article is devoted to the compilation of classification model according to the complication characteristics of anticlinal structures present at SCB. Besides the number of tectonic blocks, deposition depth of structure has also been taken into consideration when defining the complication extent of structures. Structures have been classified depending on the sea depth and complication map for the Azerbaijan sector of the Basin has been compiled for the very first time. This map can be utilized as a tool to justify the sequential exploration activities.

Keywords:

Structure;
Complication index;
Classification;
Field;
Oil and gas;
Productive.

Drilling of exploration wells conducted on structures complicated with tectonic faults in Caspian Sea shows that so as to exploring new tectonic blocks, the number of drilled wells is increased by 10% [1, 2]. This factor can be utilized for the calculation of complication coefficient of structures (CCS). If this coefficient can be considered as 1.0 for the structures complicated with tectonic faults, structures with two tectonic blocks this coefficient is 1.1, structures with three tectonic blocks this coefficient is calculated to be 1.2 etc. CCS is determined with the following mathematical formula:

$$M = 1 + \frac{T - 1}{10} \quad (1)$$

In this formula M - complication coefficient of structures;

T – number of tectonic blocks.

Besides three dimensional models, investigation of classification models is required to analyze tectonic structures at unical basins like Southern Caspian Basin (SCB) [3, 4]. Classification models are regarded as complication extents of structures (CES) which complication maps are compiled based on those models [5]. CES can be defined mathematically as following:

$$CES = f(x; y) \quad (2)$$

Here x – average deposition depth of structure, m (according to the base horizon);

y – Number of tectonic blocks in structure;

f – Defines relationship between x and y.

In case if the comparison of determination methods of structure complications is made, it would make sense that both methods can be used. But, besides the number of tectonic blocks, deposition depth of structure is taken into consideration when calculating CES which considered as a difficulty in exploration activities (fig.1). From this perspective, CES is considered as a main investigation method. It is possible to justify the sequential principle of exploration directions based on complication extents of structures and depth of sea. A new method has been proposed to diminish the geological risks of future exploration activities:

Complication extent of structure is classified into 3 classes:

1. Low complication extent – deposition depth of structure – up to 4000 m (according to the bottom of base horizon), number of tectonic blocks – up to 5.
2. Medium complication extent – deposition depth of structure – 4000-6000 m, number of tectonic blocks – up to 6-10.
3. High complication extent – deposition depth of structure – more than 6000 m, number of tectonic blocks – more than 10.

The results of CCS and CES calculations are presented in table 1.

As a result of geological-geophysical methods and exploration drilling conducted at SCB, complication extent of 51 structures has been learned and classified. It has been determined that 8 structures are in low, 23 structures are in medium, and 20 structures are in high complication extent. Since the complication extent of structure with 5 blocks is low,

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Table 1

Results of CCS and CES calculations

№	Fields and structures	Number of tectonic blocks	Depth of structure, *m* (according to the base horizons)	Depth of sea, *m*	Complication extents of structures (CES)	Complication coefficient of structures (CCS)
1	Xali	11	1200	20	high	2.0
2	Chilov	16	1400	5	high	2.5
3	Palçiq Pilpilesi	19	1650	35	high	2.8
4	Gunashli (Deep Water)	17	3000	150	high	2.6
5	Kapaz	12	4000	200	high	2.1
6	Qum-deniz	14	3600	10	high	2.3
7	Sangaçal-Duvanni-deniz-Xare-Zire	12	4500	10	high	2.1
8	Elet-deniz	20	5100	10	high	2.9
9	Bulla-deniz	9	6100	35	high	1.8
10	Shah-deniz	1	6300	300	high	1.0
11	Absheron	5	6800	450	high	1.4
12	Umid	2	6500	55	high	1.1
13	Babek	3	6500	400	high	1.2
14	Asiman	1	6500	870	high	1.0
15	Shafag	1	6500	880	high	1.0
16	Sengi Mugan	15	4500	30	high	2.4
17	Sebayil	4	6900	50	high	1.3
18	Sherq	1	6900	500	high	1.0
19	Alov	1	6900	600	high	1.0
20	Araz	1	6900	840	high	1.0
21	Gurgan-deniz	6	1800	10	medium	1.5
22	Neft Dashlari	6	1200	40	medium	1.5
23	D-30	1	4800	320	medium	1.0
24	Qaradag-deniz	1	4300	5	medium	1.0
25	8 Mart	2	5700	10	medium	1.1
26	Bahar	7	4500	30	medium	1.6
27	Sayyar	1	5200	40	medium	1.0
28	Seba	1	5200	40	medium	1.0
29	Zafar	2	5900	850	medium	1.1
30	Mashal	1	5900	670	medium	1.0
31	Hamamdag-deniz	3	4200	15	medium	1.2
32	Qarasu	10	4500	25	medium	1.9
33	Aran-deniz	8	4600	45	medium	1.7
34	Dashli	4	5500	48	medium	1.3
35	Nakhchivan	2	6000	250	medium	1.1
36	Bendovan-deniz	2	5000	10	medium	1.1
37	Yanan Tava	2	5000	20	medium	1.1
38	Atashgah	3	6000	40	medium	1.2
39	Mugan-deniz	6	5000	49	medium	1.5
40	Shirvan-deniz	2	4500	200	medium	1.1
41	Inam	8	4500	75	medium	1.7
42	Kurdashi	7	4500	35	medium	1.6
43	Lankaran-deniz	9	3500	90	medium	1.8
44	Pirallahı	5	800	10	low	1.4
45	Hazi Aslanov	3	1970	10	low	1.2
46	Cenub-1	2	3500	30	low	1.1
47	Cenub-2	1	3500	35	low	1.0
48	Oguz	2	4000	60	low	1.1
49	Azeri-Chirag-Gunashli	3	3000	180	low	1.2
50	Araz-deniz	2	4000	90	low	1.1
51	Talısh-deniz	2	3500	30	low	1.1

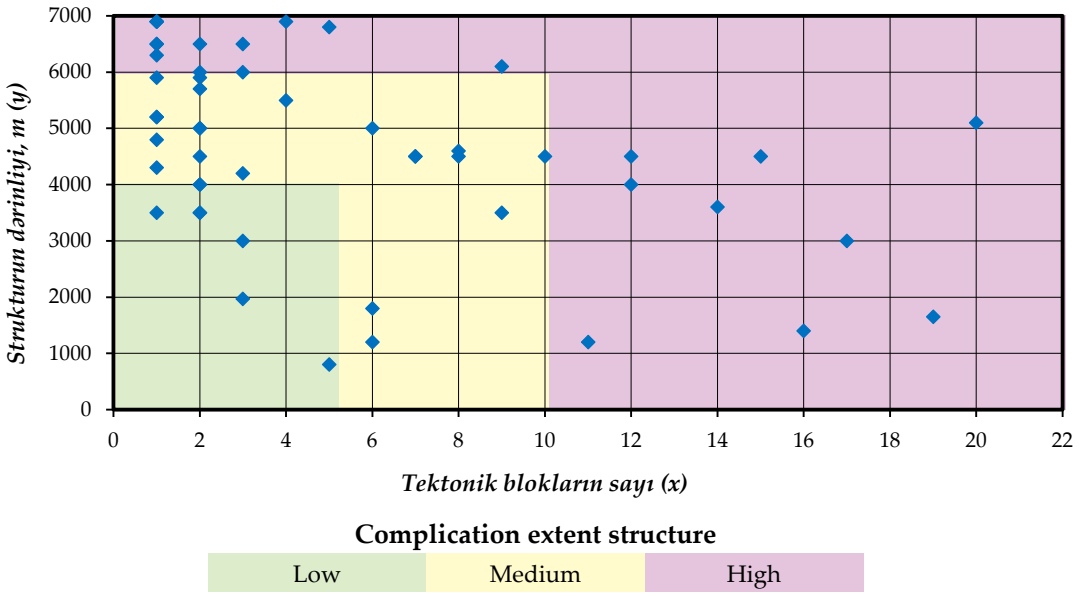

Fig.1. Determination of CES

with 10 blocks is medium, more than 10 blocks is considered as high, and then CCS would be more than 1.4; 1.9; 2 respectively. Graphical description of statistical analysis of CCS shows that complexity extent of other indefinite structures at SCB has been predicted to be low with 63% probability, medium with 19% probability, high with 18% probability (fig.2).

But, classification scheme across CES shows that, geological contradiction might be arisen to some extent. So as to evaluate the creditability of two methods, depth of the structures that has been appended to the CES classification scheme is required to be taken into account. This parameter is not taken into account in CCS.

There are 39 structures where sea depth is 200 m, and 6 structures where sea depth is 200-500 m and more than 500 m (tabl.2).

Bayes method is used to evaluate CES in uncertain structures which explored in SCB [6-8]. Bayes method enables to evaluate the analysis of different scenarios based on factual values and their probabilities. The application scheme is prepared with the help of this method to solve the current issue (fig.3).

In accordance with the geological conditions noted in the scheme, determination of possibility probabilities of variants (according to the complication extents of structures) is required (tabl.3).

Since the probability of 51 structures is accepted to be 1.00, the probability of low, medium and high complicated structures is equal to 0.16, 0.45, and 0.39 respectively. This drives the point home that the complication extent of indefinite structures which will be discovered in SCB is predicted to be medium with more probability. Besides, researches have been done according to the different sea depths.

1. The probability of structures that possess low

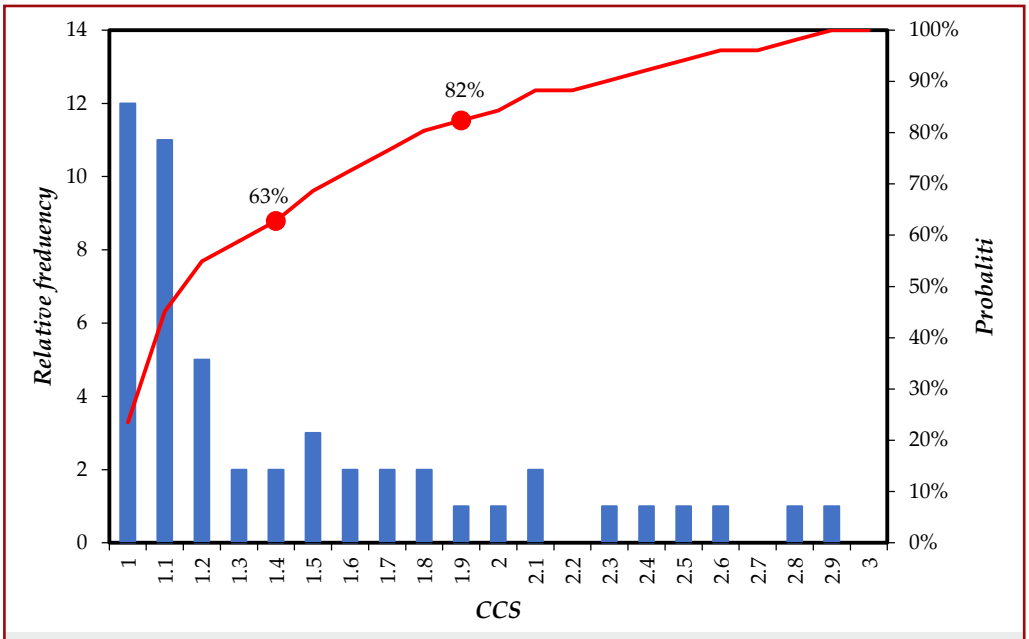

Fig.2. Distribution graph of CCS across SCB

Table 2

Classification table of structures that has been studied

Class	Sea depth, m	Complication extent of structure (CES)			Total
		Low, L	Medium, M	High, H	
I	200 >	8	19	12	39
II	200 - 500	0	2	4	6
III	500 <	0	2	4	6
Total		8	23	20	51

complication extent is calculated where the sea depth is up to 200m:

$$P(L|I) = \frac{P(L)}{P(I)} = \frac{0.16}{0.76} = 0.21 \quad (3)$$

The probability of structures possess medium and high complication extent is equal to 0.48 and 0.31 respectively. It means structures with medium complication extent can be discovered with most probability.

2. The probability of structures that possess low complication extent is calculated where the sea depth is 200-500 m:

$$P(L|II) = \frac{P(L)}{Ý(Ý)} = \frac{0.00}{} = 0.00 \quad (4)$$

The probability of structures possess medium and high complication extent is equal to 0.33 and 0.67 respectively.

3. The probability of structures that possess low complication extent is calculated where the sea depth is more than 500 m:

$$P(L|III) = \frac{P(L)}{P(III)} = \frac{0.00}{0.12} = 0.00 \quad (5)$$

The probability of structures possess medium and high complication extent is equal to 0.33 and 0.67 respectively.

4. Generally, the detection probability of structures with low complication extent at SCB is calculated as following:

$$P(L|I,II,III) = \frac{P(L,I) + P(L,II) + P(L,\ III)}{P(W)} = \frac{0.16 + 0.00 + 0.00}{1.00} = 0.16 \quad (6)$$

In this case, the probability of structures possess medium and high complication extent is equal to 0.45 and 0.39 respectively.

As it can be seen, the conducted researches are very important in terms of predicting the tectonic structure of fields, planning of exploration activities, determination of the sequence, as well as diminishing geological risks. The complication map of SCB has been compiled with the help of this information.

The fields and perspective structures that are located in Azerbaijan sector of SCB is different according to their complication extent depending on depth and number of tectonic faults. The probability of indefinite structures is different due to their complication extent. At the same time, the tectonic structure of more than 50% of the structures is not certain. The combined analysis of changes across the field and the probability of the complication extent of unknown structures helps to find out determination of risky fields and the sequence of application of exploration activities. From this perspective, compilation and analysis of complication map across SCB is an actual issue.

The complication extent of studied structures across all fields has been digitalized and sectorial characterized so as to compile a complication map.

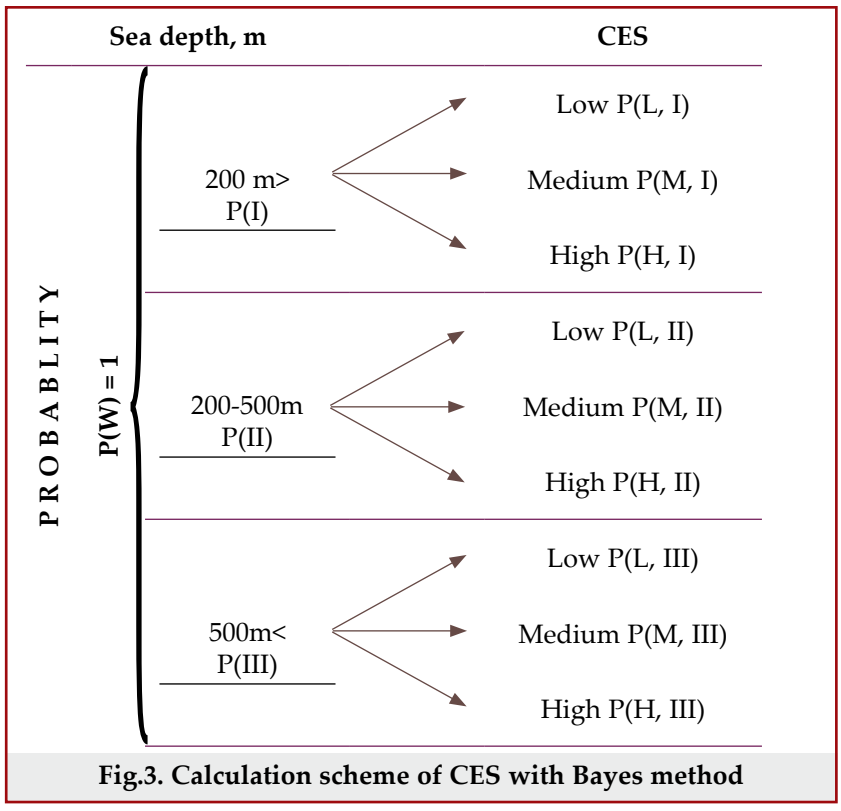

Fig.3. Calculation scheme of CES with Bayes method

Table 2

Probable values					
Class	Sea depth, m	Complication extent of structure (CES)			Total
		Low, L	Medium, M	High, H	
I	200>	0,16	0.37	0.24	0.76
II	200-500	0,00	0.04	0.08	0.12
III	500<	0,00	0.04	0.08	0.12
Total			0.45	0.39	1.00

The complication map is compiled with Kraykinq method based on the values of CES (fig.4).

The analysis of the comparison of complication and uncertainty maps enables to evaluate the risks. After evaulating CES across the field it has been found out that structures with medium complication extent at SCB will be encountered with more probability which the compiled maps also confirm this. The majority of structures at Baku and Absheron archipelagos possess medium complication extent. But, structures in deep Caspian fields are predicted to possess high complication extent.

The combined analysis of complication and uncertainty maps is accepted to be the main interpretation source to evaluate the geological risks of structure. So, the risky fields need to be determined according to the two maps in order to compile a risk map.

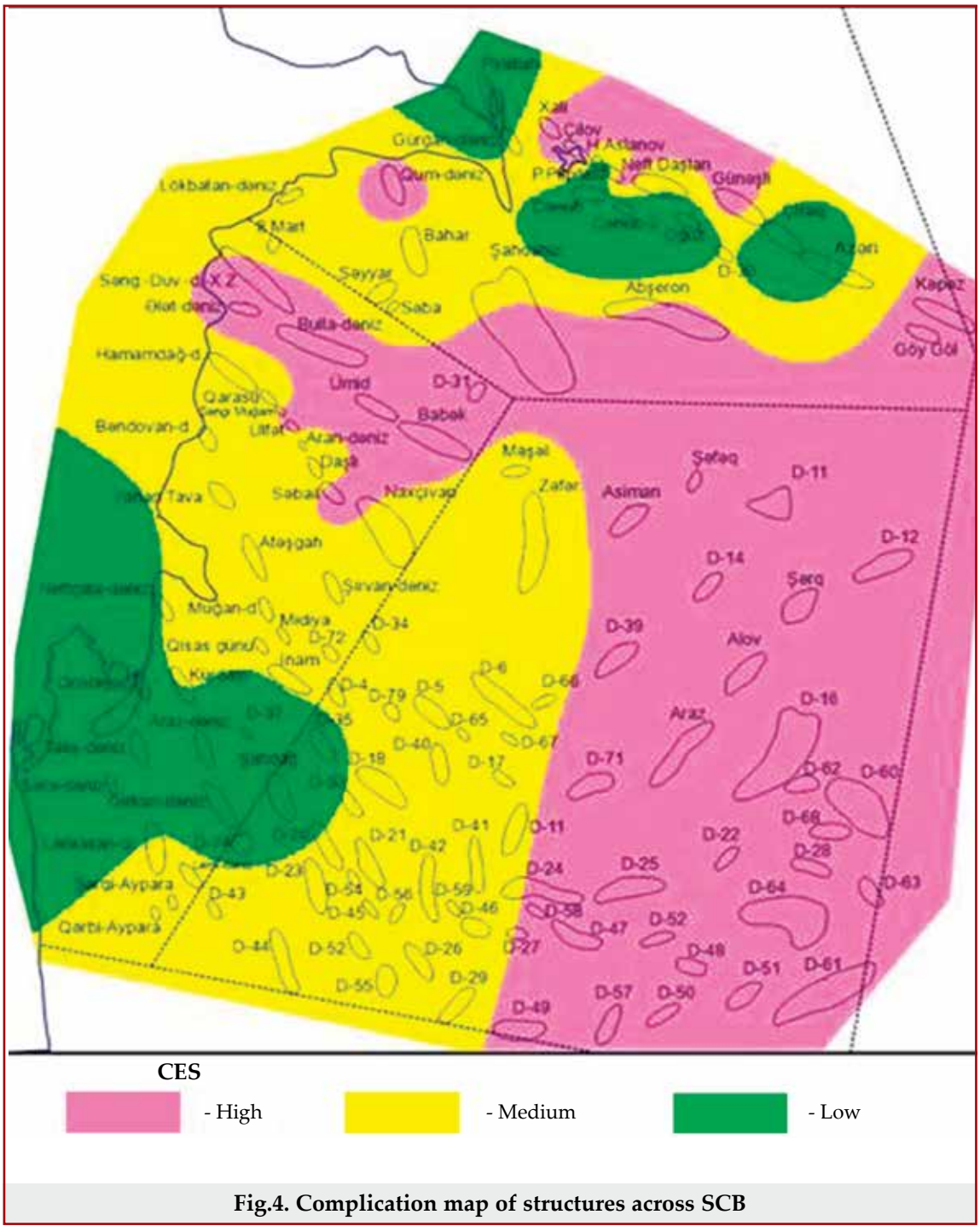

Fig.4. Complication map of structures across SCB

Results

As a result of conducted complex researches, the following is deduced:

1. Structures located at SCB are classified according to the complication extents and comparative analysis has been made.
2. The complication extent of uncertain structures has been predicted and complication map has been compiled so as to selection of complicated fields for the first time.
3. Probable values of complication extents across the field have been defined with the application of Bayes method.

These studies, compiled complication maps are very crucial in terms of the selection of risky fields, planning of exploration activities, and determination of the sequence.

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Новая классификационная модель по степени их сложности структур

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Реферат

Данная статья посвящена составлению классификационной модели по характеристикам сложности антиклинальных структур, присутствующих в ЮКБ. Помимо количества тектонических блоков, глубина осаждения структуры также была принята во внимание при определении степени сложности структур. Структуры были классифицированы в зависимости от глубины моря, и карта сложности для Азербайджанского сектора бассейна была составлена впервые. Эта карта может быть использована в качестве инструмента для обоснования последовательных геологоразведочных работ.

Ключевые слова: структура; индекс сложности; классификация; месторождение; нефть и газ; продуктивность.

Strukturların mürəkkəblik dərəcəsinə görə yeni təsnifat modeli

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Xülasə

Məqalə Cənubi Xəzər Hövzəsində mövcud olan antiklinal strukturların mürəkkəblik xarakteristikasına əsaslanan təsnifat modelinin tərtibinə həsr edilmişdir. Strukturların mürəkkəblik dərəcəsinin müəyyənləşdirilməsi zamanı tektonik blokların sayı ilə yanaşı, strukturun yatma dərinliyi də nəzərə alınmışdır. Strukturlar dənizin dərinliyindən asılı olaraq təsnif edilmiş və ilk dəfə olaraq hövzənin Azərbaycan sektoru üçün mürəkkəblik xəritəsi tərtib edilmişdir. Bu xəritə geoloji-kəşfiyyat işlərinin növbəliliyinin əsaslandırılması üçün istifadə edilə bilər.

Açar sözlər: struktur; mürəkkəblik dərəcəsi; təsnifat; yataq; neft və qaz; məhsuldarlıq.