MAIN ACTIVE FAULTS FROM THE EASTERN PART OF ROMANIA (DOBROGEA AND BLACK SEA). PART I: LONGITUDINAL FAULTS SYSTEM.

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Abstract. The main goal of this article is to decode the seismicity of the eastern part of Romania and its correlations with the active tectonic (faults systems) present in the area, in order to create a specific database for seismic hazard assessment process and also describing the faults in SHARE manner and thus to fill a gap in the project. By analyzing the active faults from onshore and offshore of Black Sea coast we contribute to the effort of assessing the tsunamigenic potential of the Black Sea areal. Our purpose is to describe the active faults, with the aim of determining geometrical and seismological parameters, using Individual Seismogenic Sources. So, we highlight ten active faults from which four faults present the tsunamigenic potential, with local effects, as follows: Sf. Gheorghe Fault, Peceneaga – Camena Fault, Capidava-Ovidiu Fault and Costinesti Fault.

Key words: active faults, earthquakes, Black Sea

1. INTRODUCTION

Identification of active faults is a key factor in seismic hazard assessment process and in evaluation of the tsunamigenic potential of the fault.

For this purpose, different projects at European level (e.g., Database of Individual Seismogenic Sources (National Institute of Geophysics and Volcanology, Rome, Italy) - DISS, Seismic Hazard Harmonization in Europe- SHARE, European Research Infrastructure on Solid Earth - EPOS or Assessment, Strategy and Risk Reduction for Tsunamis in Europe - ASTARTE) or at national level (Partnership programs or the NUCLEU program of the Ministry of Research and Innovation), tried inventory and description in specific terms of the existing faults. Basically, Database of Individual Seismogenic Sources - DISS (http://diss.rm.ingv.it/diss/) represents the basis of the description of the faults in terms of the geometrical parameters and allows a permanent updating [1]. It was taken over and developed in the European Database of Seismogenic Faults (EDSF) of the SHARE project hosted by Instituto Nazionale di Geofisica e Vulcanologia, Italy. The DISS rationale and descriptions are presented in [2], [1], [3] and [4].

Other examples that can be given in this context are the overview of Northern Italy and Western Slovenia seismogenic sources in DISS manner [5], the investigation of the Central Apennines seismotectonics [6]; the study of the Adriatic seismogenic sources [7] and the evaluation of the slip rates of thrust and fold belt from External Dinarides [8] and PO Plain (Northern Italy) [9].

Aspects concerning faults in the eastern part of Romania and the seismogenic sources for seismic hazard assessment discussed by [10], the active faults in the Black Sea coast by [11], structural configuration of the western sector of the Black Sea by [12], study of tectonic processes in front of Carpathians and Dobrogea by [13], investigations of Peceneaga-Camenea and Sf. Gheorghe Faults by [14], structural arrangement of the Western Black Sea Basin by [15], tectonic map of the eastern part of Romania based on gravimetric data [16], tectonic map based on gravimetric and magnetic data [17], and structural investigations of western Black Sea Basin based on the seismic reflection data [18], [19].

At European level Romania is not represented by important results in predicting faults, active or not. In the SHARE project (www.share-eu.org) the Romanian faults are not included in maps and project documentation. Some of the faults from Black Sea, Romanian sector, are included in ASTARTE (www.astarte-project.eu) project and are directly related to tsunamigenic potential assessment.

The goal of this paper is to define the active faults in the eastern part of the country using DISS methodology and to introduce this data in the European scientific flow.

In order to define the active faults, the following elements have been taken into account:

- Geometrical parameters, such as: length, active length, width and depth of the earthquakes foci.
- Seismological parameters, such as: strike, dip, rake (slip);
- Correlation of the seismicity with the known fault system.

The studies on active tectonics have clearly shown the position of the seismic sources (connected to well define active faults) which do not result in alternatives of other model constructions.

In the studied area, we identified three fault systems: a longitudinal, a transversal and an oblique one. The present work is a first step in our investigation presenting the results regarding only the main faults of the longitudinal system.

2. Geotectonic consideration

Black Sea Basin represents a back-arc basin opened in the early Cretaceous-Early Paleogene subduction of the Neotethys below the Balcanides-Pontides volcanic arc ([12], [18]). The basin of the Black Sea is surrounded by a system of Alpine orogenic chains, such as: Balkanides-Pontides, Caucasus-Crimea system and North Dobrogea and Strandja-Sakarya zones ([8]). Deep seismic reflection studies like [20], [21] demonstrate the existence of two extensional sub-basins, one to the West, called Western Black Sea Basin, and another to the East, called Eastern Black Sea Basin; these basins are separated by the continental uplifted block called Mid-Black Sea Ridge (or Andrusov Ridge).

The Western Black Sea Basin was opened after the separation of the Istanbul zone from the Moesian Platform in Aptian-Albian rifting phase (Early Cretaceous). The East Black Sea Basin was opened as a response of the Late Paleocene rifting phase (in the Eocene).

The Western Black Sea basin consists of 4 major tectonic units (Fig. 1):

A) East European Platform, which extends to the Black Sea from on shore. This tectonic unit has a crust thickness of 40-45 km and consists of a basement of gneiss, granite, granitoid with basic and ultrabasic rocks and a sedimentary cover of Paleozoic, Mesozoic Cenozoic age ([16]);

B) The Scythian Platform, which is of Precambrian age, when it was delimited from a system of major overthrusts, with regional characteristics and northern vergences, such as Chilia, Snake Island, Sulina-Tarhankut and Golitin overthrusts. This unit is bounded to the South by the Sulina -Tarhankut fault and to the North by the Trotus fault;

C) Northern Dobrogea, which represents a relative narrow area of Hercynian age situated between the Scythian Platform at North and Moesian Platform at South, bounded by Sulina-Tarhankut fault to the North and Peceneaga-Camena fault to the South. Northern Dobrogea has a complex structure, being formed by several tectonic units, between them being an overthrusting relation, the vergence being oriented to the North-East. The main tectonic units are Macin, Niculitel and Tulcea nappe;

D) Moesian Platform border westwards the Black Sea and spreads toward North, from Peceneaga-Camena fault until South, in front of Balkans, being formed from a Baikalian basement and a Phanerozoic sedimentary cover ([11]).

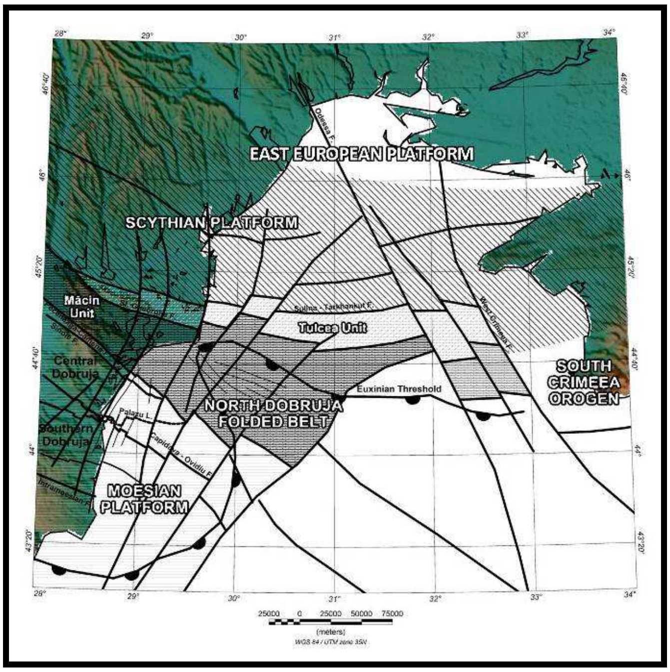

Fig.1. Tectonic map of the WESTERN BLACK SEA BASIN (after [22])

The Western Black Sea Basin (Fig. 2) consists of three fault systems. The first one is represented by the prolongation of the terrestrial faults in marine domain, such as: Snakes Island, Sulina-Tarhankut, Sf. Gheorghe, Pelican, North Heracleea and Heracleea, Portita, Sinoe, Peceneaga-Camena, Horia-Pantelimonul de Sus, Capidava - Ovidiu, North Agigea, Costinesti, Mangalia, Vama Veche Faults.

The second system comprises faults parallel to the Black Sea coast: Constanta, Razelm, Lacul Rosu, West Midia Faults. According to [11], the third system of faults is represented by the NW-SE oriented faults like Nistru, Odessa, West Crimea.

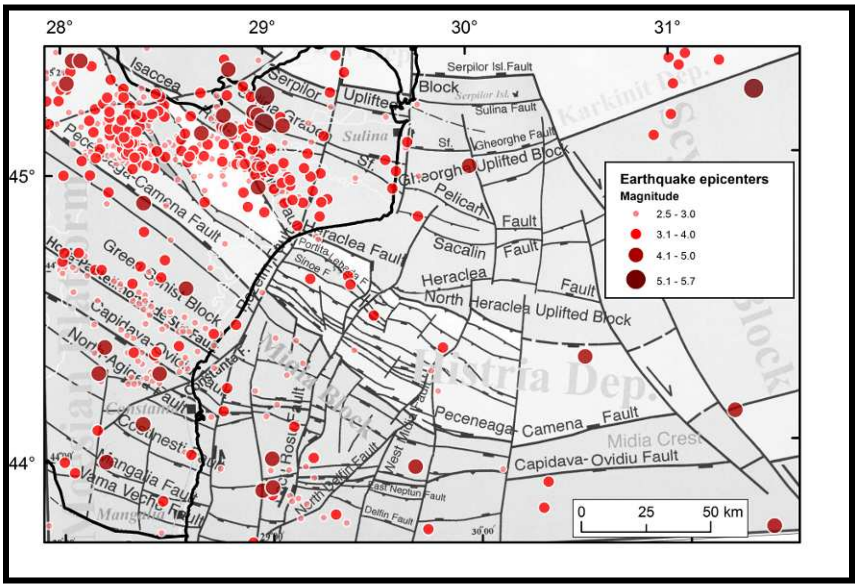

Fig. 2. Tectonic map of the Romanian shelf, red dots are earthquakes (tectonics after [15], [17])

3. Methodology of Fault's Description

Active faults can be described using different parameters, as described in Table 1. [1] distinguished three main categories of Seismogenic Sources: Individual Seismogenic Sources (Fig. 3), Seismogenic areas and Macroseismic sources. Our study is providing geometrical and seismological for the active faults, using only the first category of seismogenic sources.

Individual Seismogenic Sources (Fig. 3) are defined by geological and geophysical data (see Table 1) and are characterized by a full set of geometric (strike, dip, length, width and depth), kinematic (rake), and seismological parameters (single event displacement, magnitude, slip rate). As such, Individual Seismogenic Sources can be used for simulating earthquake and tsunami scenarios and for tectonic and geodynamic investigations [1]. Every parameter of each Individual Seismogenic Source is qualified according to the type of analysis that was done to determine it. The qualifiers are defined as follows:

- Original Data (OD): unpublished original measurements and interpretations for the purposes of this Database;

- Expert Judgement (EJ): assignments made by the compiler on the basis of tectonic information or established knowledge at a larger scale than that of the seismogenic source under consideration and data collected from studies published in scientific journals and technical reports of research projects [1].

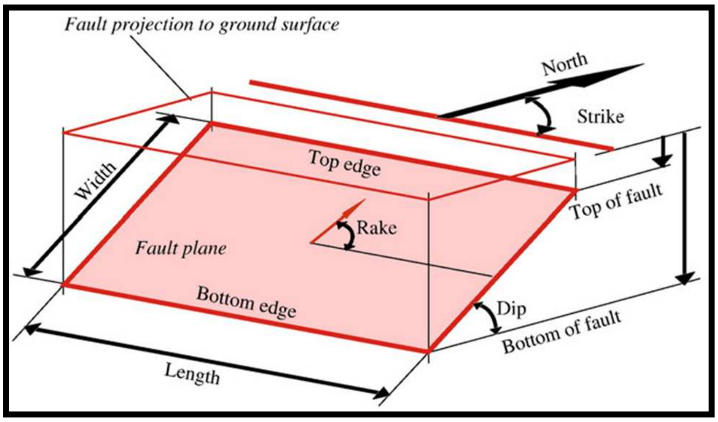

Fig. 3. Schematic representation of an Individual Seismogenic Source and its characteristics [1]

Table 1

Main types of data and methods used to obtain the parameters of individual seismogenic sources (modified after [1])

Parameter	Appropriate data and methods
Length	• Geological maps of faults expressed at the surface. • Geological sections across the active fault system. • Scaling relationship between length and moment magnitude ([23]).
Active length	• Length of epicentral area
Width	• Geological sections across the active fault system. • Width of the epicentral area. • Scaling relationship between width and moment magnitude ([23]).
Depth	• Depth distribution of instrumental earthquakes. • Geological sections across the active fault system.
Strike, Dip, and Rake/Slip	• Displacement components of geological markers in maps and cross sections • Focal mechanisms of the larger associated earthquakes
Magnitude	• Largest magnitude of associated earthquake(s) measured instrumentally. • Magnitude inferred from the area of the largest associated fault or fault set. • Scaling relationship between magnitude and fault size ([23])

In order to describe the faults from seismological point of view we use 40 earthquakes (Fig.4) with fault plane solutions in terms of nodal planes (Table 2).

The fault plane solutions have been obtained on the basis of the P-wave polarities using FOCMEC code developed by [24] – incorporated in SEISAN software [25]. For our estimations, the selected threshold is 7 polarity data for 11 earthquakes; between 7 to 10 polarity data for 4 earthquakes, for another 17 earthquakes, most of the events, the number of available observations is greater than 10; and 8 earthquakes are from different papers.

Geometrically, we described the faults by his length and wide, taking in consideration the maps generated by [15], based on reflection seismic lines (Fig. 5) and [16], based on gravimetric data. Another map was generated by [17], based on gravimetric, magnetic and magnetotelluric soundings.

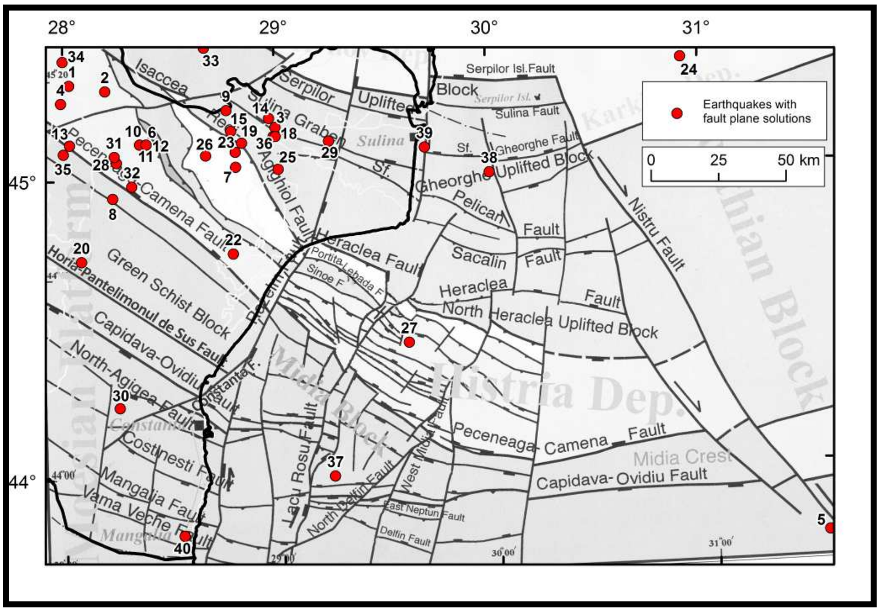

Fig. 4. Earthquakes with fault plane solutions on the tectonic background. Numbers indicate the current event number in Table 2.

4. Results

According to the distribution map of the earthquake epicenters and as well as to the map of the areas with active tectonics, 10 seismic sources were identified in previous work and summarized in [10]. This classification is very useful for seismic hazard assessment. Another way to understand better the seismic context is to use a tectonic approach, in which we present the active faults such as: Sf. Gheorghe, Sinoe, Peceneaga-Camena, Horia-Pantelimonul de Sus, Capidava-Ovidiu, Costinesti, North Agigea, Mangalia and Vama Veche Faults (Fig. 2). We characterize faults by using: geometrical parameters width, depth, length, length of the faults and seismological parameters; strike, dip rake and maximum magnitude.

The maximum observed magnitude is evaluated from the strongest earthquakes that occurred along a fault.

Table 2.
Earthquakes with fault plane solutions for onshore and offshore Black Sea Coast (Dobrogea)

No.	Date	hh:mm:ss	Lat.N	Long.E	Depth (km)	Mw	PLANE 1			PLANE 2			NS/ References
							Strike	Dip	Rake	Strike	Dip	Rake	
1	11.09.1980	23:24:25	45,32	28,03	20,4	4,2	338	9	17	52	87	99	[26]
2	09.11.1980	23:24:24	45,30	28,2	15	*	282	89	175	12	85	1	[26]
3	13.11.1981	09:07:13	45,17	29	15	5,1	213	65	180	303	90	25	[27]
4	04.02.1985	23:37:15	45,26	27,99	15	3,2	197	38	-144	76	69	-58	18/OD
5	03.03.1986	07:26:03	43,76	31,51	18	4,6	75	47	63	292	50	116	[26]
6	08.06.1988	11:03:45	45,12	28,39	5	2,9	142	27	70	344	65	100	7/[28]
7	09.05.1991	15:21:36	45,04	28,81	10	3,1	191	83	136	288	47	10	7/OD
8	03.06.1992	22:21:00	44.94	28.23	16	3.1	238	74	-159	136	55	-160	[29]
9	19.08.1994	20:21:00	45.23	28.77	0	2.8	158	45	341	261	77	-46	[30]
10	21.08.1997	08:49:42	45,12	28,36	10	2,7	55	84	102	171	13	27	7/OD
11	06.08.1998	11:03:45	45,12	28,39	5	2,9	300	36	15	198	81	125	7/OD
12	08.05.1999	11:06:18	45,12	28,39	5	2,9	342	66	105	128	28	59	7/OD
13	19.01.2001	15:12:47	45,12	28,03	33	3,2	306	82	38	210	53	170	10/OD
14	03.10.2004	09:02:07	45,20	28,97	31	4.8	289	27	-129	152	70	-72	[26]
15	24.11.2004	18:36:55	45,16	28,79	3	3.3	117	57	65	338	41	123	29/OD
16	18.03.2005	15:43:01	45,57	27,8	11	3.9	244	50	26	136	70	137	7/OD
17	10.042005	02:03:41	45,48	27,64	10	2,1	260	68	178	351	88	22	8/OD
18	04.01.2006	23:53:05	45,14	28,99	5,9	3	60	81	159	159	85	-168	16/OD
19	19.01.2006	20:58:06	45,12	28,84	1	2,8	273	83	176	7	89	77	10/OD
20	06.02.2006	10:47:06	44,73	28,08	30	3.0	293	32	62	145	62	106	9/OD
21	30.10.2007	17:56:03	45,49	27,63	50	4.0	13	31	146	133	73	164	10/OD
22	02.02.2008	01:44:39	44,75	28,79	5	2,2	16	64	57	251	41	138	7/OD
23	26.02.2008	13:55:47	45,09	28,81	7,5	2,5	340	63	70	199	33	124	10/OD
24	07.05.2008	08:00:21	45,36	30,92	17,4	4,9	45	42	59	264	55	115	[26]
25	26.05.2008	08:28:13	45,03	29,01	9,3	2,6	304	89	0	214	90	179	11/OD
26	15.08.2008	09:17:17	45,08	28,67	5	2,7	287	88	43	195	47	178	9/OD
27	25.08.2008	22:54:00	44.44	29.60	15	3.2	152	88	-42	244	48	-177	27/OD

28	23.10.2008	09:58:06	45,06	28,25	5	2,6	12	59	48	252	50	138	10/OD
29	06.01.2009	02:20:30	45,12	29,25	5	2,3	34	89	54	303	36	178	7/OD
30	20.08.2009	08:12:44	44,24	28,25	17,4	3,2	230	77	138	301	49	17	14/OD
31	15.09.2009	08:51:02	45,08	28,24	11	2	157	85	34	63	56	174	7/OD
32	15.09.2009	09:45:15	44,98	28,32	10	2,8	170	82	2	80	88	172	7/OD
33	09.11.2009	00:20:24	45,44	28,67	13,8	2,2	375	37	116	63	58	72	10/OD
34	08.02.2010	20:59:10	45,40	28,155	8,8	2,2	256	63	148	1	62	31	7/OD
35	20.04.2010	10:57:55	45,09	28,244	3,4	2	191	72	134	299	47	26	8/OD
36	13.09.2010	14:22:09	45,14	28,752	2	2,4	80	89	35	349	25	179	10/OD
37	28.03.2011	08:58:14	43,791	29,24	0,3	2,5	171	75	23	75	67	164	14/OD
38	04.05.2011	10:05:04	45,088	29,705	10	3,3	289	47	55	155	53	122	23/OD
39	04.05.2011	10:43:03	45.09	29.7	10	3.2	181	48	80	15	42	100	21/OD
40	24.08.2011	19:58:03	43.81	28.54	4	3.1	342	15	-43	114	80	-101	20/OD

For the hazard purposes, equations like the ones proposed by [23]) can be used to estimate the maximum possible magnitude, derivable from the active length of the fault.

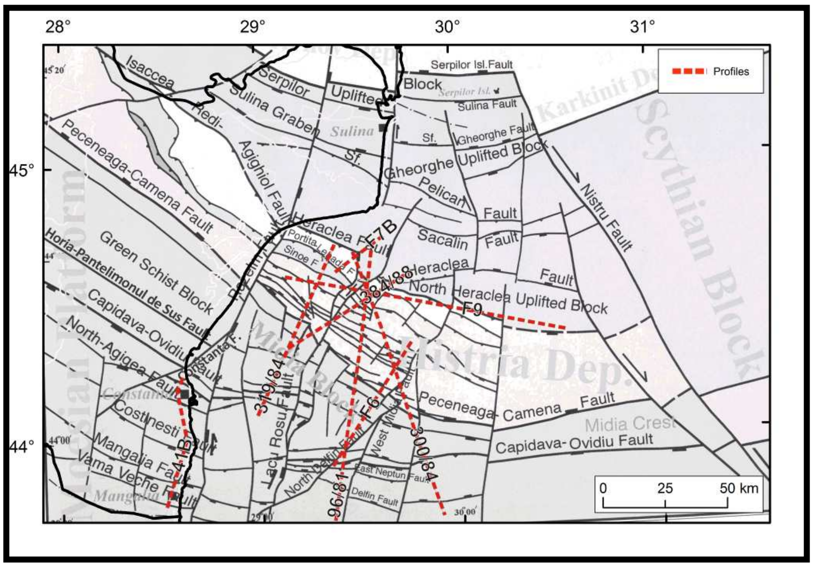

Fig.5. Distribution of the seismic lines on the tectonic background (tectonic map source: [15])

Table 3.

Parameters of Sf. Gheorghe Fault (update from [11]) (represented on Fig. 1, Fig. 2, Fig. 4, Fig. 5 and Fig. 6)

Total length (km)	419 such as:	EJ	Inferred from regional tectonic considerations [11]
Active length (km)	219 (until Lacul Rosu Fault)	OD	Inferred from earthquakes distribution
Wide (km)	4	OD	Inferred from earthquakes distribution
Minimum depth (km)	0	OD	Inferred from earthquakes distribution
Maximum depth (km)	31	OD	Inferred from earthquakes distribution
Strike (degree)	120	OD	Based on fault plane solutions, see earthquake no.3, table 2
Dip (degree)	85	OD	Based on fault plane solutions no.3, table 2
Rake (degree)	335	OD	Based on fault plane solutions no.3, table 2
Max magnitude	5.1 (M_w) (13 November 1981)	OD	Based on the strongest earthquake occurred along fault no.3, table 2

Sf Gheorghe Fault has a complex character which consists of two segments: a southern one, and respectively a northern one. The southern segment is situated at a distance of 1 km from the northern one and is a reverse fault and affects formations of Paleozoic and Triassic age. The northern segment is a normal fault, almost vertical, affecting formations of Paleozoic, Triassic, Mesozoic and the lower Cretaceous ages. [15] consider the northern segment as an extension of Sf. Gheorghe fault from land into the sea, ending on the West Crimea fault. [18], [19] and [12] consider, on contrary, that the southern branch is an offshore extension of Sf. Gheorghe fault. The fault plane solutions present a strike slip faulting.

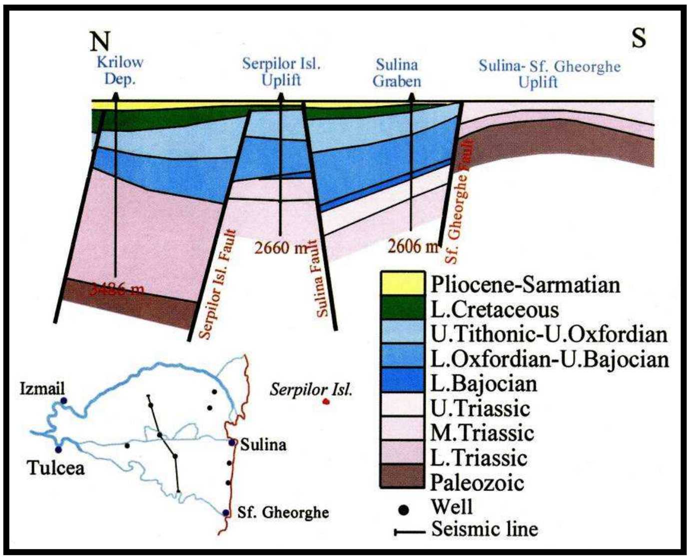

Fig. 6. Geological crossection through Danube Delta (from [15]).

Sf. Gheorghe fault delimits to the north the North Dobrogea from Scythian Platform and presents composite characteristics with a dextral movement as a result of the thrust of North Dobrogea over Scythian Platform. As significnt earthquakes, we mention the event occurred on November 13, 1981 of Mw=5.1 and the event occurred on October 3, 2004 of Mw= 3.7 ([31]) NW of the Tulcea city. The first event was felt up to Constanta, Braila, Galati cities and even at Chisinau city (Republic of Moldova).

Table 4

Parameters of Sinoe Fault (update from [11]) (represented on Fig. 2 and Fig. 8)

Total length (km)	36.48 km	EJ	Inferred from regional tectonic considerations [11]
Active length (km)	35.9 km	OD	Inferred from earthquakes distribution
Wide (km)	1.3 km	OD	Inferred from earthquakes distribution
Minimum depth (km)	0	OD	Inferred from earthquakes distribution
Maximum depth (km)	13	OD	Inferred from earthquakes distribution
Strike (degree)	244	EJ	Fault plane solution of earthquake 68
Dip (degree)	88	OD	Fault plane solution of earthquake 27, table 16
Rake (degree)	-42	OD	Fault plane solution of earthquake 27, table 16
Max magnitude	3.2 md (25.08. 2008)	OD	Based on the strongest earthquake occurred along fault

The Sinoe reverse fault with southern vergency [18] is parallel to Lebada-Portita fault and defines the southern limit of the Niculitel and Macin nappes to its Northern limit [12]). It is the prolongation of Luncavita –Consul Fault on offshore ([15]).

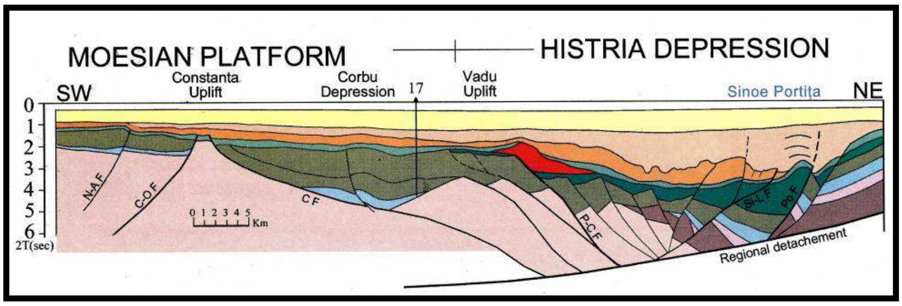

Fig. 7. Geological interpretation of the seismic line 319/88 (for location see Fig. 4). N-A F- North Agigea Fault; C-O F- Capidava – Ovidiu Fault, CF- Constanta Fault, P-C F-Peceneaga Camena Fault, Si-L F- Sinoe Fault; PoF-Portita Fault (for location see Fig. 4) (from [15]).

Table 5.

Parameters of Peceneaga-Camena Fault (update from [11]) (represented on Fig. 1, Fig. 2, Fig. 6, Fig. 7, Fig. 9)

Total length (km)	421	EJ	Inferred from regional tectonic considerations [17],[15], [11]
Active length (km)	297	OD	Inferred from earthquakes distribution
Wide (km)	2	OD	Inferred from earthquakes distribution
Minimum depth(km)	1	OD	Inferred from earthquakes distribution
Maximum depth (km)	18	OD	Inferred from earthquakes distribution
Strike (degree)	N129.19 E to N102E	OD	Based on fault plane solutions, 22,13, 21, Table 2
Dip (degree)	46-90	OD	Based on fault plane solutions. Earthquakes number 21, 22 and 13 from Table 2
Rake (degree	-38 to 140		Based on fault plane solutions. Earthquakes number 21,22 and 13 from Table 2
Max magnitude	4.2 Mw (19.11.1900)	OD	Based on the strongest earthquake occurred along fault

The NW–SE trending Peceneaga-Camena crustal fault separates Central Dobrogea (green schist area) from North Dobrogea, onshore, and is mapped approximately 100 km eastward on the Romanian shelf; it has an apparent sinistral character and is associated with a large number of smaller scale strike slip faults.

This fault is a lithospheric scale structure defined onshore as the Southern margin of the Cimmerian Triassic□Jurassic North Dobrogea Orogen (Fig. 1), located in the SE European prolongation of the Tornquist–Teisseyre Lineament ([15] and references therein). A number of high angle normal faults splay off the Peceneaga Camena fault system and are coeval with its main strike slip activity.

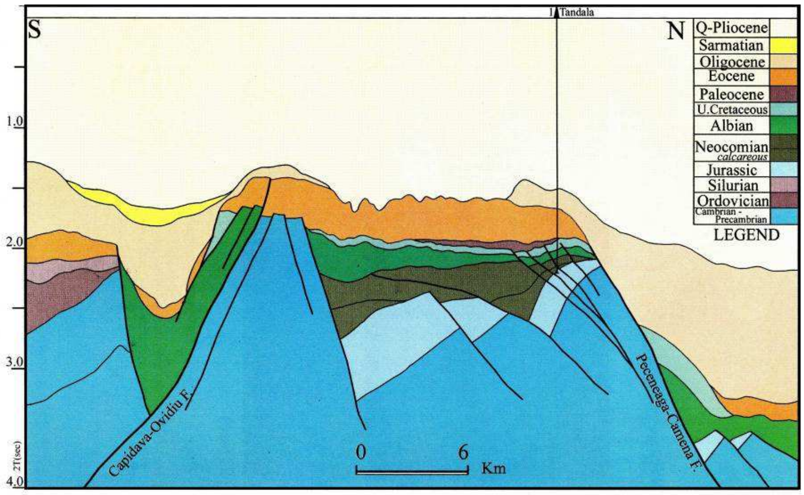

Fig. 9. Geological interpretation of the seismic line 96/81(for location see Fig.4) (from [15])

The Peceneaga–Camena Fault separates the North Dobrogea and Moesian units, with an estimated decrease in the crustal thickness of the later of 10 km. This fault has been repeatedly displaced during the late Alpine evolution of the overlying foredeep and is currently active as part of a broad normal fault system with Moesia as the hanging-wall, with events occurring from its Black Sea prolongation all the way to the north, to the Moesian Platform [14]

Table 6.
Parameters of the Horia-Pantelimonul de Sus Fault (represented on Fig. 2 and Fig. 4)

Total length (km)	185	EJ	Inferred from regional tectonic considerations [17],[15]
Active length (km)	180	OD	Inferred from earthquakes distribution
Wide (km)	3	OD	Inferred from earthquakes distribution
Minimum depth (km)	1	OD	Inferred from earthquakes distribution
Maximum depth (km)	30	OD	Inferred from earthquakes distribution
Strike (degree)	N 120 E to N 140E,	EJ	Inferred from regional tectonic considerations [17],[15] and fault plane solution earthquake no. 19 from Table 2
Dip (degree)	80-90	EJ	Inferred from regional tectonic considerations [17], [15]and fault plane solution earthquake no. 19 from Table 2
Rake (degree)	176		Earthquake no.19 from Table 2
Max magnitude	2.8	OD	Based on the strongest earthquake occurred along fault

Horia-Pantelimonul de Sus Fault is almost vertical with the Northern compartment up and a NW-SE direction. It is a Northern branch of the Capidava – Ovidiu fault system.

Table 7.

Parameters of Capidava-Ovidiu Fault (after [11]) (represented on Fig. 1, Fig. 2, Fig. 4, Fig.9, Fig.10 and Fig.11)

Total length (km)	363:	EJ	Inferred from regional tectonic considerations [17], [15]
Active length (km)	180	OD	Inferred from earthquakes distribution
Wide (km)	6	OD	Inferred from earthquakes distribution
Minimum depth (km)	1	OD	Inferred from earthquakes distribution
Maximum depth (km)	33	OD	Inferred from earthquakes distribution
Strike (degree)	N 120 E to N 140E	EJ	Inferred from regional tectonic considerations [17], [15]
Dip (degree)	80-90	RJ	Inferred from regional tectonic considerations [17], [15]
Rake (degree)	-		Non-available
Max magnitude	4.5 Mb (27.04.1986)	OD	Based on the strongest earthquake occurred along fault

Known also as Palazu, the Capidava–Ovidiu fault is a NW–SE trending crustal fault which separates Central Dobrogea (green schist area) from South Dobrogea with Moesian type basement [32]. The Capidava–Ovidiu fault was inactive during the opening the West basin of the Black Sea. As strike slip fault, almost vertical with southern compartment down and/or raised at the transition from terrestrial domain to marine domain [15]. Capidava-Ovidiu is a deep fault which crosses the Conrad discontinuity [33].

Table 8.

Parameters of North Agigea Fault (represented on Fig. 2 and Fig. 9)

Total length (km)	234	EJ	Inferred from regional tectonic considerations [12], [15]
Active length (km)	200	OD	Inferred from earthquakes distribution
Wide (km)	1-5	OD	Inferred from earthquakes distribution
Minimum depth (km)	1	OD	Inferred from earthquakes distribution
Maximum depth (km)	35	OD	Inferred from earthquakes distribution
Strike (degree)	N 56 W to N109 E	OD	Inferred from regional tectonic considerations ([12],[15]) and fault plane solution, earthquakes no.30
Dip (degree)	77	OD	Inferred from regional tectonic considerations [12], [15] and fault plane solution earthquake no. 30 in table 2
Rake (degree)	138	OD	Fault plane solution of earthquake of earthquake no.30, table 2

Max magnitude	3.2(M_w)/20 august 2009	OD	Based on the strongest earthquake occurred along fault

An uplifted basement block (Eforie uplift) can be observed between the Agigea and Costinesti faults. To the North, the North Agigea fault bounds the Agigea-East Neptun high. On the terrestrial domain, the fault has a strike slip character with a normal component (the compartment form South is down) and very slow dip to the South. Between East Razelm and Red Lake faults it has a reverse character. Agigea fault has a regional character being observed until Danube river.

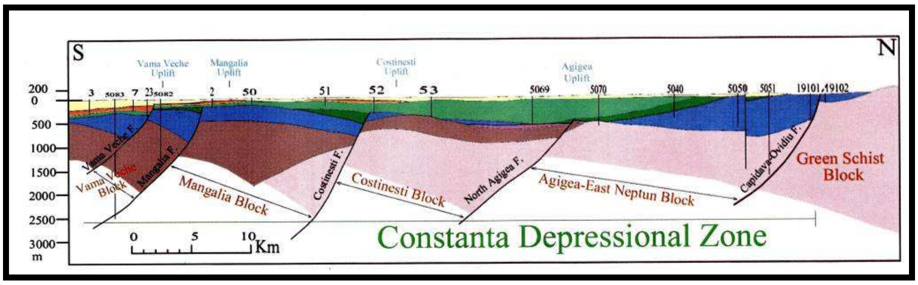

Fig. 10. Geological crossection through wells. Line 41B (for location see Fig. 4), (from [25])

Table 9.

Parameters of Costinesti Fault (represented on Fig. 2 and Fig. 10)

Total length (km)	211.59	EJ	Inferred from regional tectonic considerations ([17], [15], [11])
Active length (km)	111.59	OD	Inferred from earthquakes distribution
Wide (km)	3	OD	Inferred from earthquakes distribution
Minimum depth (km)	2	OD	Inferred from earthquakes distribution
Maximum depth (km)	20	OD	Inferred from earthquakes distribution
Strike (degree)	N 125 E to N 87, 5 E	OD	Inferred from regional tectonic considerations ([17],[15]) and fault plane solution no 37
Dip (degree)	75	OD	Based on fault plane solutions of earthquake no 37 from table 2
Rake (degree)	23		Based on fault plane solution of earthquake no 37 from table 2
Max magnitude	5 M_L (12.12.1986)	OD	Based on the strongest earthquake occurred along fault

Costinesti Fault is a normal fault on terrestrial domain and reverse fault in marine domain. The changes in fault type take place at the intersection with Razelm Fault. Costinesti fault, a longitudinal fault, has a regional character, affected by thick sedimentary layers of Jurassic and cretaceous ages.

Table 10.

Parameters of Mangalia Fault (represented on Fig. 2 and Fig. 10)

Total length (km)	130	EJ	Inferred from regional tectonic considerations ([15])
Active length (km)	92.48 terrestrial only	EJ	Inferred from earthquakes distribution
Wide (km)	5	EJ	Inferred from earthquakes distribution
Minimum depth (km)	0	EJ	Inferred from earthquakes distribution
Maximum depth (km)	33	EJ	Inferred from earthquakes distribution
Strike (degree)	N 120 E to N 101 E	EJ	Inferred from regional tectonic considerations and earthquake fault plane solution no 39
Dip (degree)	80	OD	earthquake fault plain solution no. 40, table 2
Rake (degree)	-101	OD	earthquake fault plane solution no. 40, table 2
Max magnitude	4.2 Mb (21.01.1983)	OD	Based on the strongest earthquake occurred along fault

Mangalia Fault is normal, with vergencies to the South, and defines to the North the uplifted basement block called Mangalia uplift and to the South the Vama Veche block ([15]). It is a regional, longitudinal fault, with a west to east orientation.

1. CONCLUSIONS

The structures located in the western part of the Black Sea can be extended from the onshore area (Dobrogea) eastward into deep sea basin until Odessa fault (Fig. 1). The offshore tectonic elements (major faults) are prolongation of the tectonic elements from onshore, which in fact belongs to the longitudinal faults system, delimiting an alternation of basement horsts and grabens (for extended explication see [12]).

Besides setting up an important source in defining seismic sources for seismic hazard purpose, the description of these active faults, as well as the rest of active faults from Romania, is a necessary step in filling a gap in the SHARE and EPOS projects, as well as ensuring their inclusion in the European Database of Seismogenic Faults.

The faults in discussion cannot generate a tsunami [34] by themselves, but in connection with transversal faults they could constitute a tsunami generator intersection (see [35]). Basically, the transversal faults system breaks and shifts all the longitudinal faults system. Thus, the segments of the longitudinal faults are too small to generate earthquakes with high magnitudes and energy. [34] states that only earthquakes with a magnitude higher than 7.5 with normal or reverse faulting of the focal mechanisms can produce tsunami at shallow depth. Despite this fact, the National Center for Environmental Information (www.ngdc.nooa.gov) from

NOAAA (National Oceanic and Atmospheric Administration) recognized as a valid tsunami also an earthquake of 5.1 (M_S) from 4 December 1970 with 0.8 m maximum waves height. From this point of view a discussion concerning the tsunamigenic potential of faults from the western part of the Black Sea basin is useful. Taking into account the maximum magnitude observed, the length of the fault and the deep of the earthquakes, Sfantul Gheorghe, Heracleea, Pecenega-Camena, Capidava-Ovidiu and Costinesti faults must remain in attention for the future.

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3. Assessment, Strategy and Risk Reduction for Tsunami in Europe, Astarte, 603839/2013.

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