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Research Article

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Biomarker Characteristics of Triassic Kasımlar Formation; Akseki–Anamas Platform, Western Taurus, Turkey

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Abstract The Triassic Kasımlar Formation units located are composed of bituminous shale, sandstone and limestone in the Akseki–Anamas Platform (Western Taurus, Turkey). This study evaluates the biomarker parameters calculated using the 191 triterpane and m/z 217 sterane distributions obtained thru GC-MS analysis performed on the surface samples. Sterane distribution is C_{29}>C_{27}>C_{28} where C_{29} and C_{27} steranes show bimodal distribution. According to this distrubition, relative abundance of C_{28} shows green algea and diatom and relative abundance of C_{27} indicates red algae and planktons while C_{29} indicates higher plants, green and red algae. The dominant sterol is C_{29} in the majority of the higher plants. In spite of that analyzed samples do not have terrestrial characteristics, C_{29} ratios are somewhat higher than the C_{27} ratios (C_{27}; 38%, C_{29}; 42%). And this means petroleum originated from marine carbonate rich source rocks might be rich in C_{29} which shows algeal composition. The C_{31} 17α(H), 21β(H)-30 Homohopane (22R)/C_{30} ratio is 1.59, pointing carbonate–marine shale and marls. Similarly, the existence and relatively abundance of C_{29} hopane, the C_{29}/C_{30} ratio (>0.6), the C_{22}/C_{21} tricyclic terpane (0.5), the C_{24}/C_{23} tricyclic terpane (0.43) and the Ts/Ts+Tm (0.46) ratios all point to a carbonate lithology. The Diasterane/Sterane ratio is quite low (0.39) which supports all these findings. The 20S/(20S+20R) ratio (0.95) and the ββ/(ββ+αα) sterane ratio (0.53) indicate maturation. ββ/(ββ+αα) sterane and 20S/(20S+20R) ratios show maturity. The existence of C_{30} sterane points to a marine environment supported by the Sterane/Hopane (1.24) ratio. Accordingly the major part of organic matter could originate from marine material although some terrestrial input.

Keywords Biomarker, Kasımlar Formation, Organic Geochemistry, Isparta Angle, Akseki-Anamas Platform

Introduction

The study area is located in the western part of the Taurus Belt (SW Turkey), known as “the Isparta Angle” (Figure 1). This region exhibits a complex structure involving two autochthonous units surrounded with the allochthonous complexes. The autochthonous units are parts of the Beydağları micro-plate to the west and of the Anatolian micro-plate to the east (Anamas-Akseki platform). The Anamas-Akseki platform represents the SW margin of the Anatolian micro-plate located to the NE of the Isparta Angle. These platform is also composed of shallow marine carbonates and clastic sediments from Triassic time up to Eocene.

In these units, organic materials are known in the Kasımlar Formation (Figure 2-3) . This formation consists of dark-grey bituminous shale and bedded blackish reefal limestones. Previous studies of this region have defined and described the rock units, sedimentary associations, stratigraphy, tectonics and petroleum geology. General geological investigations and reports have been presented by [5-9], who studied the sedimentological character

and tectonics of the study area and environs. Petroleum-geological studies have also been carried out; important ones include the works of [10-13].

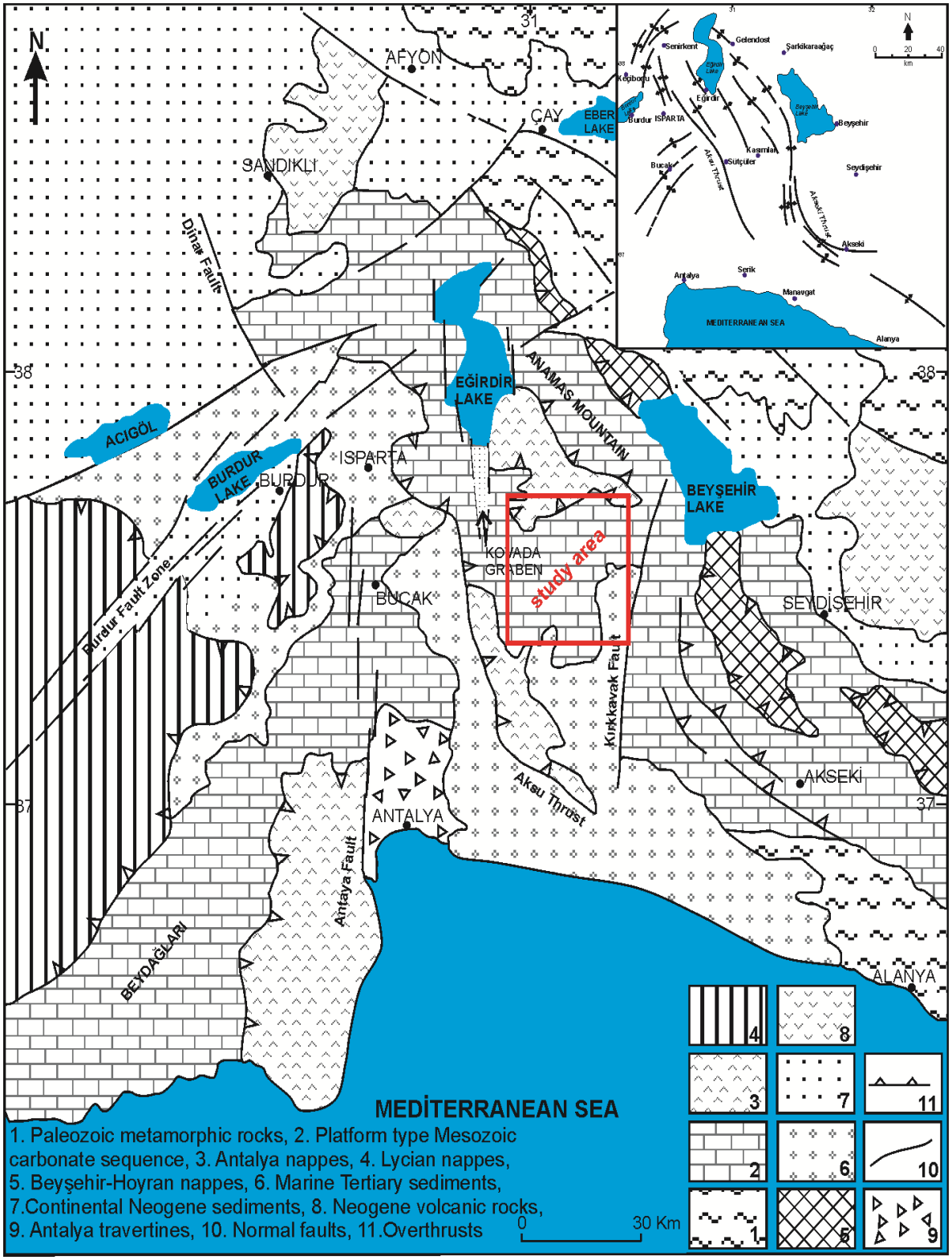


Figure 1: Simplifield geological map of the Isparta Angle and surrounding areas (modified from [1-4])

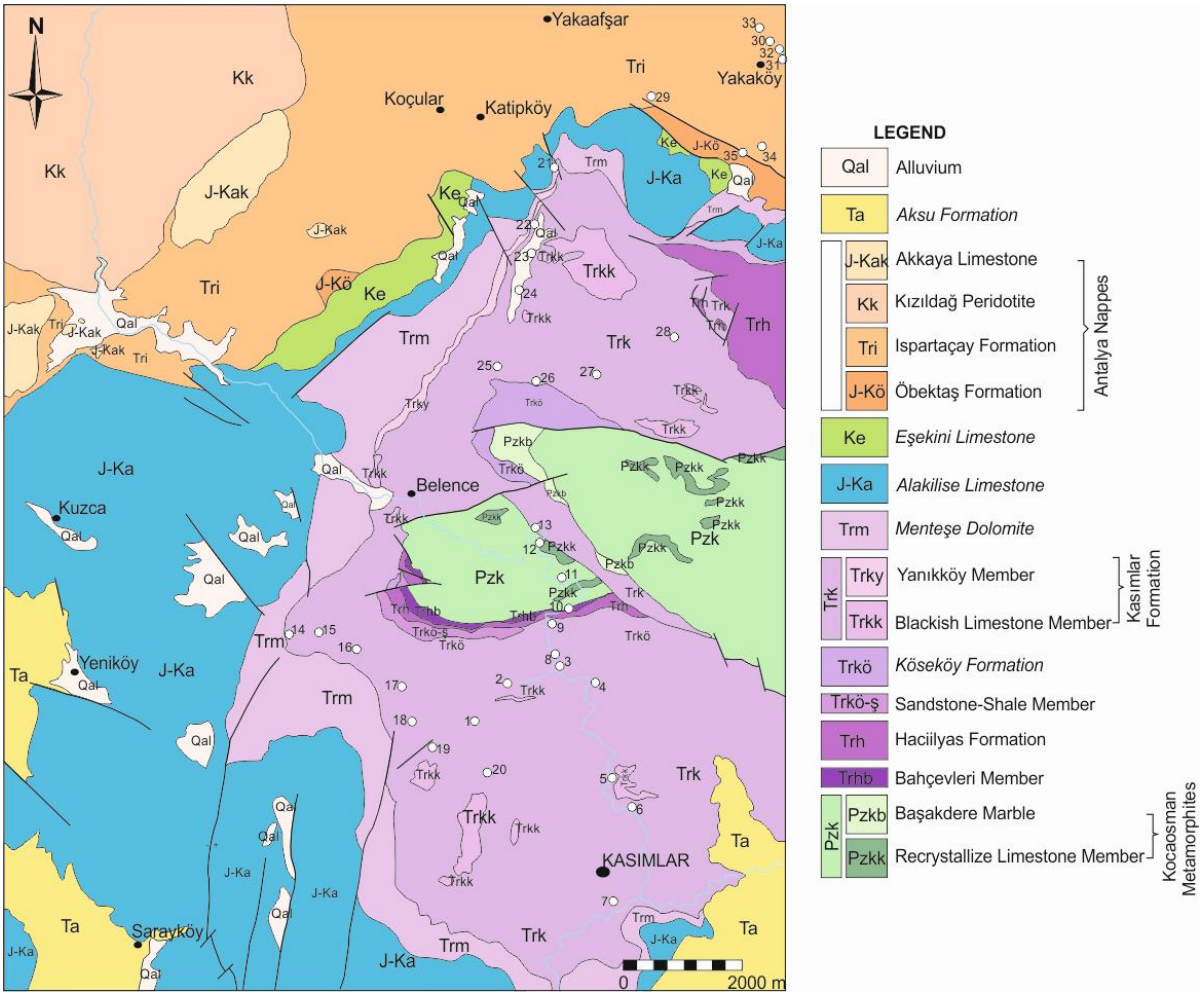


Figure 2: Geological map of the investigated area [4]

Materials and Methods

For biomarker analyses, composite sample was extracted for approximately 40 h using dichloromethane (CH_2Cl) in an ASE 300 (accelerated solvent extraction). The saturated fractions were analyzed using an Agilent 7890A/5975C gas chromatography-mass spectrometry (GC-MS) equipment. Steranes and triterpanes were calculated by measuring peak heights in the m/z 217, m/z 191 chromatograms, respectively. The samples were analyzed in the laboratories of the Turkish Petroleum Corporation (TPAO; Turkey, Ankara) Research Group.

Result and Discussion

This study evaluates the biomarker parameters calculated using the 191 triterpane and m/z 217 sterane distributions (Figure 4) obtained through GC-MS analysis performed on the surface samples. Sterane distribution is C_{29}>C_{27}>C_{28} where C_{29} and C_{27} steranes show bimodal distribution (Figure 4, Table 1). According to this distrubition, relative abundance of C_{28} shows green algea and diatom and relative abundance of C_{27} indicates red algae and planktons while C_{29} indicates higher plants, green and red algae. The dominant sterol is C_{29} in the majority of the higher plants. In spite of that analyzed samples do not have terrestrial characteristics, C_{29} ratios are somewhat higher than the C_{27} ratios (C_{27}; 38%, C_{29}; 42%). And this means petroleum originated from marine carbonate rich source rocks might be rich in C_{29} which shows algeal composition.

The C_{31} 17α (H), 21β (H)-30 Homohopane (22R)/C_{30} ratio is 0.25, pointing carbonate – marine shale and marls. Similarly, the existence and relatively abundance of C_{29} hopane, the C_{29}/C_{30} ratio (>0.6), the C_{22}/C_{21} tricyclic terpane (0.5), the C_{24}/C_{23} tricyclic terpane (0.43) and the Ts/Ts+Tm (0.46) ratios all point to a carbonate lithology. The Diasterane/Sterane ratio is quite low (0.39) which supports all these findings.

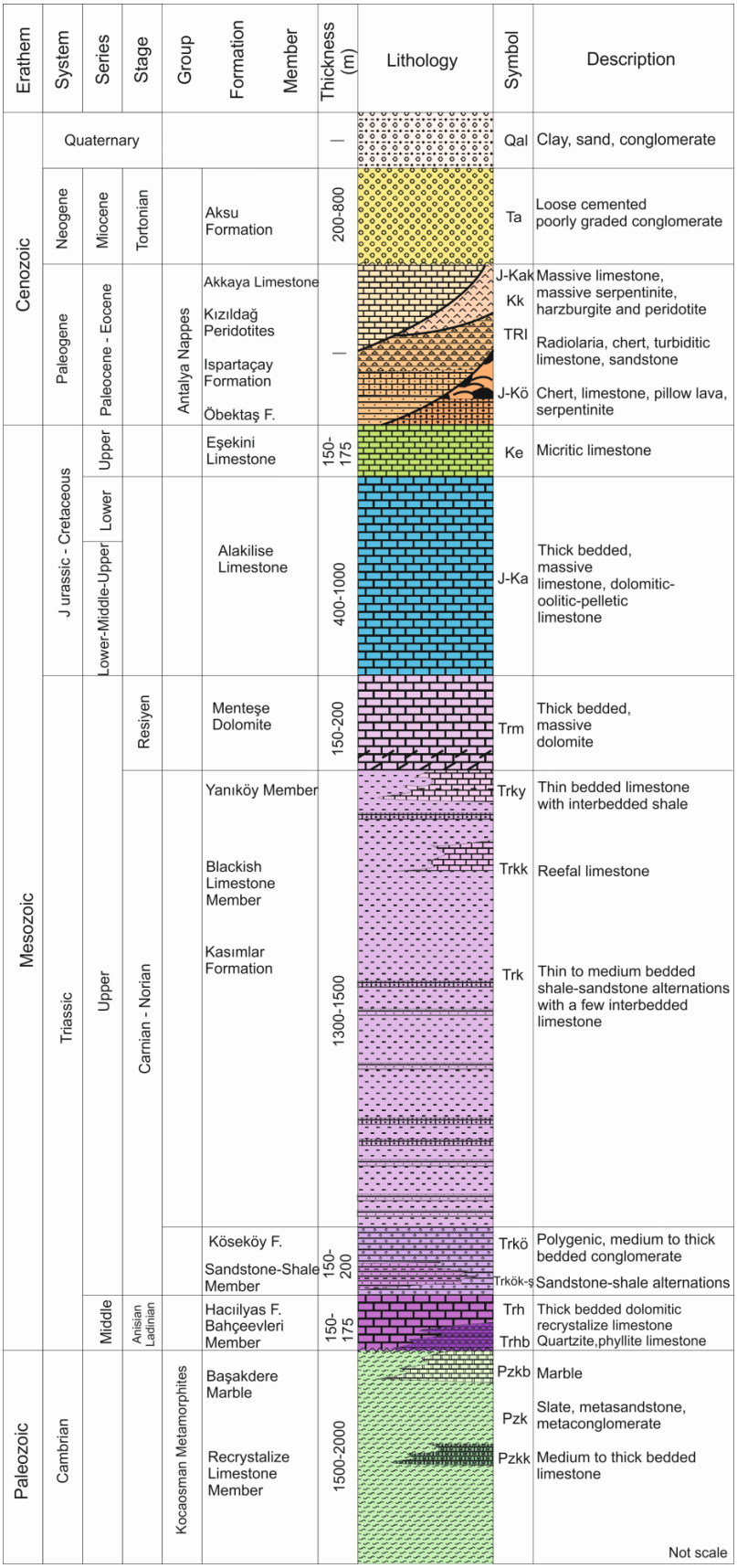
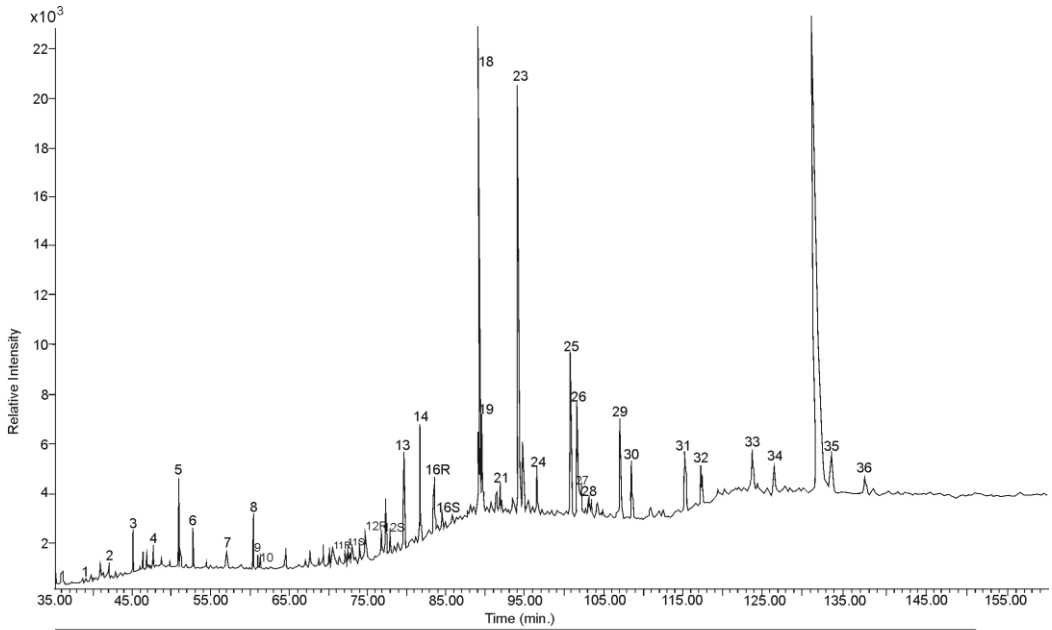
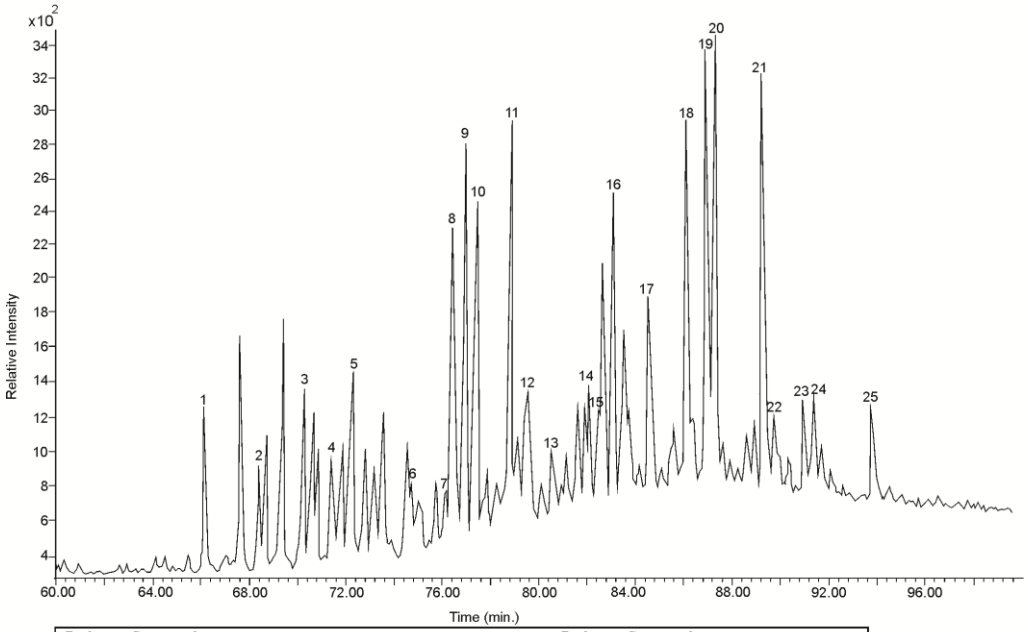


Figure 3: Generalized stratigraphic succession in the investigated area [4]



Peak	Compound	Peak	Compound	Peak	Compound
1-	C_{19} Tricyclic Terpane	13-	C_{27} 18α(H)-22,29,30-Trisnorneohopane (Ts)	25-	C_{31} 17α(H), 21β(H)-30-Homohopane (22S)
2-	C_{20} Tricyclic Terpane	14-	C_{27} 17α(H)-22,29,30-Trisnorhopane (Tm)	26-	C_{31} 17α(H), 21β(H)-30-Homohopane (22R)
3-	C_{21} Tricyclic Terpane	15-	17α(H)- 29,30-Bisnorhopane	27-	Gammacerane
4-	C_{22} Tricyclic Terpane	16-	C_{30} Tricyclic Terpane	28-	Homomoretane
5-	C_{23} Tricyclic Terpane	17-	17α(H)- 28,30-Bisnorhopane	29-	C_{32} 17α(H), 21β(H)-30,31-Bishomohopane (22S)
6-	C_{24} Tricyclic Terpane	18-	C_{29} 17α(H), 21β(H)-30-Norhopane	30-	C_{32} 17α(H), 21β(H)-30,31-Bishomohopane (22R)
7-	C_{25}(22S+22R) Tricyclic Terpane	19-	C_{29} Ts (18α(H)-30-Norhopane)	31-	C_{33} 17α(H), 21β(H)-30,31,32-Trishomohopane (22S)
8-	C_{24} Tetracyclic Hopane (Seco)	20-	C_{30} (17α(H)-Diahopane)	32-	C_{33} 17α(H), 21β(H)-30,31,32-Trishomohopane (22R)
9-	C_{26}22(S) Tricyclic Terpane	21-	C_{29} 17β(H), 21α(H)-30-Normoretane	33-	C_{34} 17α(H), 21β(H)-30,31,32,33-Tetrakishomohopane (22S)
10-	C_{26}22(R) Tricyclic Terpane	22-	Oleanane	34-	C_{34} 17α(H), 21β(H)-30,31,32,33-Tetrakishomohopane (22R)
11R-	C_{28} Tricyclic Terpane (R)	23-	C_{30} 17α(H), 21β(H)-Hopane	35-	C_{35} 17α(H), 21β(H)-30,31,32,33,34-Pentakishomohopane (22S)
11S-	C_{28} Tricyclic Terpane (S)	24-	C_{30} 17β(H), 21α(H)-Moretane	36-	C_{35} 17α(H), 21β(H)-30,31,32,33,34-Pentakishomohopane (22R)
12R-	C_{29} Tricyclic Terpane (R)				
12S-	C_{29} Tricyclic Terpane (S)				



Peak	Compound	Peak	Compound
1-	C_{27} 13β(H), 17α(H)-Diasterane (20S)	13-	C_{29} 13α(H), 17β(H)- Diasterane (20S)
2-	C_{27} 13β(H), 17α(H)-Diasterane (20R)	14-	C_{28} 5α(H), 14α(H), 17α(H)- Sterane (20S)
3-	C_{27} 13α(H), 17β(H)-Diasterane (20S)	15-	C_{28} 5α(H), 14β(H), 17β(H)- Sterane (20R) + C_{29}
4-	C_{27} 13α(H), 17β(H)-Diasterane (20R)	16-	C_{28} 5α(H), 14β(H), 17β(H)- Sterane (20S)
5-	C_{28} 13β(H), 17α(H)-Diasterane (20S)	17-	C_{28} 5α(H), 14α(H), 17α(H)- Sterane (20R)
6-	C_{28} 13β(H), 17α(H)-Diasterane (20R)	18-	C_{29} 5α(H), 14α(H), 17α(H)- Sterane (20S)
7-	C_{28} 13α(H), 17β(H)-Diasterane (20S)	19-	C_{29} 5α(H), 14β(H), 17β(H)- Sterane (20R)
8-	C_{27} 5α(H), 14α(H), 17α(H)-Sterane (20S)+C_{28} 13α(H), 17β(H)-Diasterane (20S)	20-	C_{29} 5α(H), 14β(H), 17β(H)- Sterane (20S)
9-	C_{27} 5α(H), 14β(H), 17β(H)-Sterane (20R)+C_{29} 13β(H), 17α(H)-Diasterane (20S)	21-	C_{29} 5α(H), 14α(H), 17α(H)- Sterane (20R)
10-	C_{27} 5α(H), 14α(H), 17α(H)-Sterane (20S)+C_{28} 13α(H), 17β(H)-Diasterane (20R)	23-	C_{30} 5α(H), 14β(H), 17β(H)- Sterane (20R)
11-	C_{27} 5α(H), 14α(H), 17α(H)-Sterane (20R)	24-	C_{30} 5α(H), 14β(H), 17β(H)- Sterane (20S)
12-	C_{29} 13β(H), 17α(H)- Diasterane (20R)	25-	C_{30} 5α(H), 14α(H), 17α(H)- Sterane (20R)

Figure 4: Distrubitions of m/z 191 (hopanes) and m/z 217 (steranes) in selected composite sample

The 20S/(20S+20R) sterane and ββ/(ββ+αα) sterane increase with maturity equilibrium values of 0.55 and 0.70, respectively [14-15]. 20S/(20S+20R) ratio (0.95) and the ββ/(ββ+αα) sterane ratio (0.53) indicate maturation. Moretane is thermally less stable than hopane and the moretane/hopane ratio decreases with maturity [16-17]. Very low moretane/hopane ratio (0.10), high values of the Ts/(Ts+Tm) ratio indicate maturity. The existence of C_{30} sterane points to a marine environment supported by the Sterane/Hopane (1.24) ratio. Accordingly the major part of organic matter could originate from marine material although there are terrestrial input.

Table 1: Biomarker compositions based on m/z 191, 217 mass chromatograms and calculated parameters for composite sample from the Kasımlar Formation

Parameters	Composite sample
Sterane/Hopane Ratio	1.24
C_{32} 22S/(22S+22R) Ratio	0.61
Moretane/Hopane Ratio	0.1
C_{29}/C_{30} Hopane Ratio	1.15
Ts/(Ts+Tm) Ratio	0.46
C_{24}/C_{23} Tricyclicterpane Ratio	0.43
Gammacerane Index	1.41
Diasterane/Sterane Ratio	0.39
ββ/(ββ+αα) Sterane Ratio	0.53
% C_{27}	38.04
% C_{28}	19.97
% C_{29}	41.99
20S/20S+20R	0.95
C_{28}/C_{29} Sterane Ratio	0.63
C_{31} Hopane (R)/C_{30} Hopane Ratio	0.25
C_{24} Tetracyclic terpane/C_{30} Hopane Ratio	0.13
C_{25}/C_{26} Tricyclic terpane Ratio	0.37
C_{24}/C_{26} Tricyclic terpane Ratio	1.12
C_{35}/C_{31}-C_{35} Hopane Ratio	0.07
Norhopane/Hopane Ratio	6.33
C_{22}/C_{21} Tricyclic terpane Ratio	0.5
C_{27}/C_{29} Terpane ratio	0.38
C_{23}/C_{23+} C_{30} Hopane Ratio	0.68

Conclusion

The distribution values of m/z 191 triterpane and m/z 217 sterane of the Triassic bituminous shale in Kasımlar Formation were determined by GC-MS. According to the C_{27}, C_{28} and C_{29} sterane distribution, it can be observed that the dominant sterol is C_{29} in majority of the higher plants. C_{29} ratios are somewhat higher than the C_{27} ratios (C_{27}; 38%, C_{29}; 42%). Petroleum originating from marine carbonate rich source rocks might be high in C_{29} which shows algeal composition. The C_{31} 17α(H), 21β(H)-30 Homohopane (22R)/C_{30} ratio C_{29} hopane, the C_{29}/C_{30} ratio, the C_{22}/C_{21} tricyclic terpane, the C_{24}/C_{23} tricyclic terpane and the Ts/Ts+Tm indicate carbonate-marine shale and marls lithology. ββ/(ββ+αα) sterane and 20S/(20S+20R) sterane ratios show maturity.

Acknowledgement

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