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Research Article

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Detrital modes and provenance of the Lutetian Sandstones (Bozbel Formation, Sivas Basin, Turkey)

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Abstract The Bozbel Formation (Lutetian) of the Sivas Basin, Turkey, displays a range of lithofacies which vary greatly in thicness. The formation consist of conglomerates, sandstones, mudstones and shales, marls, limestones and sandy limestones, tuffites and volcanic breccias. Some 60 sandstone thin sections from the Bozbel Formation were analysed petrographically, using the 500 point volumetric counting method. The resulting data were re-calculated on a cement-free matrix-free basis, using total quartz total feldspar and total rock-fragments as end- members of triangular compositional diagrams. The sandstones can be classified essentially as arkose, lithic arkoses and feldspathic litharenites, cement-rich and containing minor amounts of olivine, pyroxene, chlorite, biotite, muscovite and opaque minerals. Under appropriate conditions, it is possible to utilise the relative proportions of the major detrital components of sandstones to deduce the geotectonic nature of the source-areas supplying the detritus. Using this approach, three broad types of provenance field can be distinquished, using the relative abundances of quartz, feldspar and rock fragments (lithics) on a cement and matrix-free basis. Bozbel Formation sandstones were derived from magmatic arc and mix provenances. This deductions concerning the provenance of the Bozbel turbitides are fully compatible with the general geological framework of these deposites. The sandstones contain magmatic clasts derived from the obducted ophiolitic slices that form part of the basement of the basin, demonstrating uplift and reworking of this magmatic material during early Cenozoic time.

Keywords Sandstone, Provenance, Lutetian, Sivas Basin, Turkey

1. Introduction

The Sivas Tertiary Basin were created in Anatolia (Turkey) as a result of early Ceonozoic collisional events (Figure 1). The basement of the basin is the Divriği ophiolitic melange, emplaced tectonically during the Late Cretaceous (Figure 2). The Upper Cretaceous-Palaeocene Tecer Formation (shelf limestones) rest unconformably upon the ophiolitic melange and both these units subsequently have been thrust over the younger sequence. These basement sequences are unconformably overlain by conglomerates of the Ypresian Bahçecik Formation, which pass upwards into the dominantly turbidite sequence of the Bozbel Formation (Lutetian). The Bozbel Formation begins with submarine debris-flow conglomerates which fine upwards into turbiditic sandstones, shales, mudstones and limestones which gradually shoal upwards into alternating sandy limestones, gypsiferous layers and limestone breccias. This succesion is unconformably overlain by Oligocene clastic beds and evaporates and these sequence is unconformably the followed by conglomerates, sandstones, marls and gypsium layers of the Miocene Hafik and Karacaören Formations. The Miocene succession is capped by alluvial conglomerates, sandstones, siltstones and claystones, on top of which Quaternary fluvial sediments occur unconformably (Figure 3). There have been many geological studies in this basin, for example by[1-7]The aim of this study is to determine the clastic petrofacies/detrial modes and describe the provenances of the Bozbel Formation(Lutetian) sandstones.

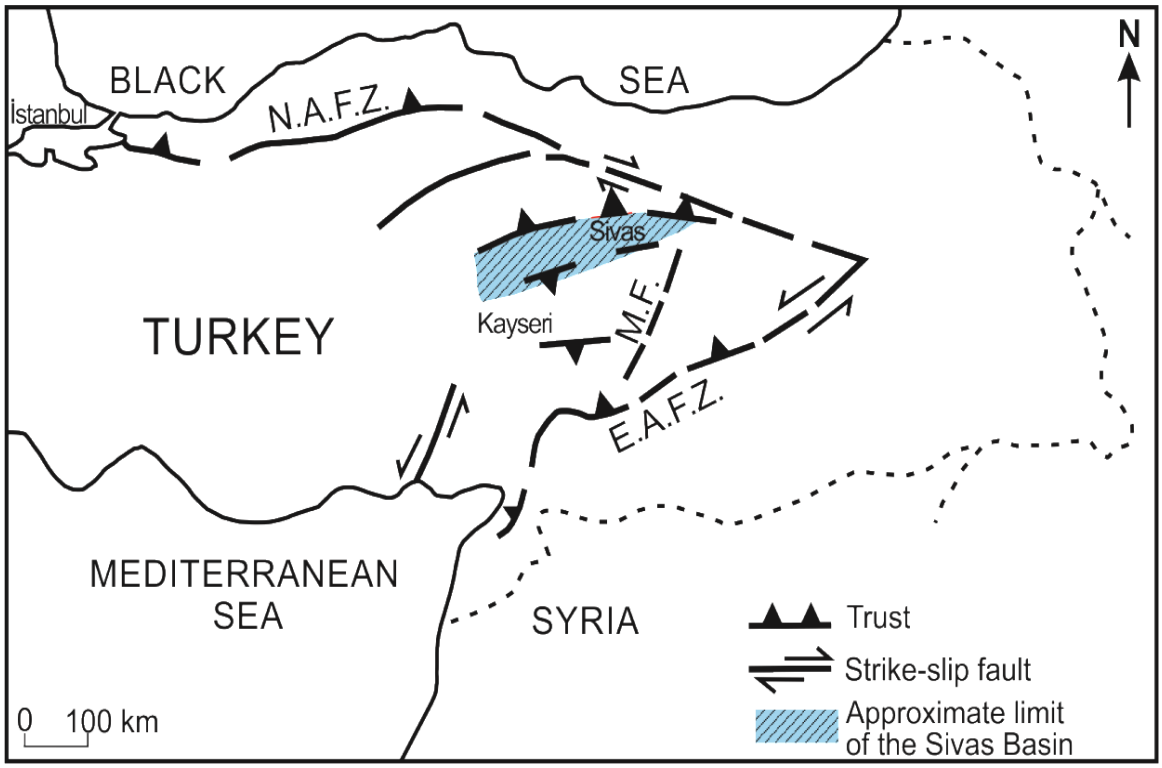

Figure 1: Location map of the investigated area [7]

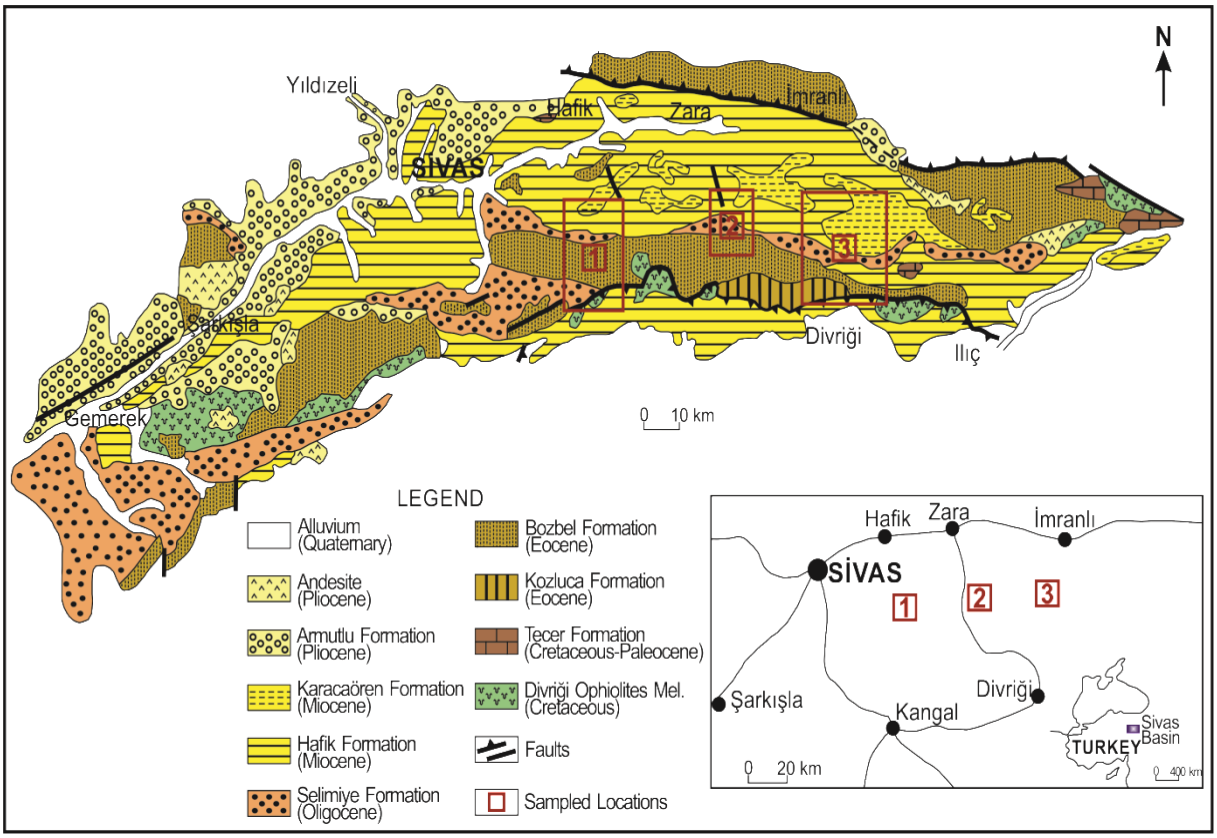

Figure 2: Simplified geological map and sample locations of the Sivas Tertiary Basin[7]

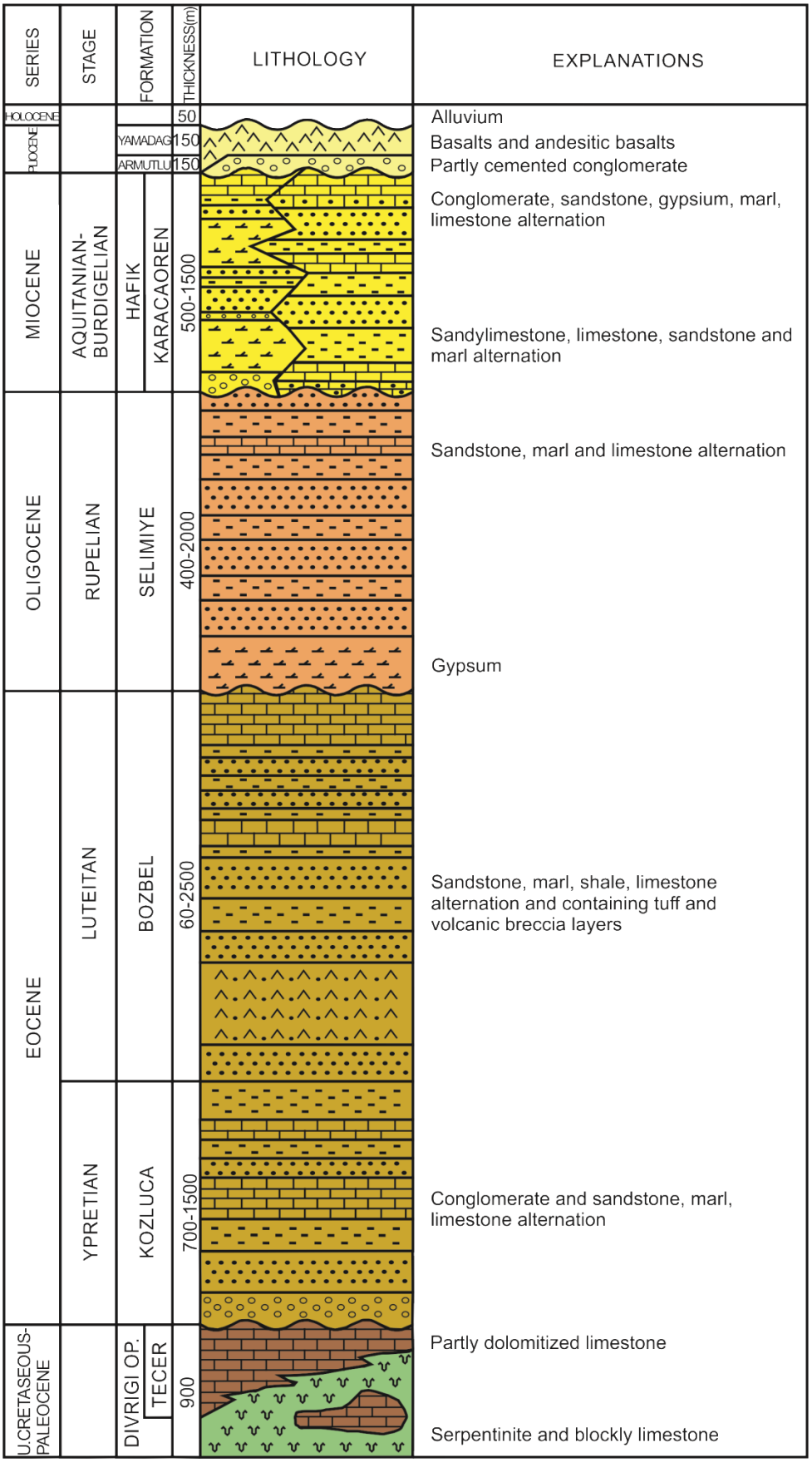

Figure 3: Generalized stratigraphic section of the investigated area [7]

Results and Discussion

For the present study, seven vertical stratigraphic section of the Bozbel Formation were measured. Some 60 sandstone thin sections from the Bozbel Formation were analysed petrographically, using the 500 point volumetric counting method. The resulting data were re-calculated on a cement-free matrix-free basis, using total quartz total feldspar and total rock-fragments as end- members of triangular compositional diagrams (Figure 4). Polycrystalline and monocrystalline quartz forms are present in the determined sandstones, which contain total amounts of quartz varying from 1.6- 33 %. Polyquartz grains are commonly large and coarsly crystalline and of fine to medium sand size. The total content of feldspars range from 2-79 % and is dominated by calcium rich plagioclase.The total rock fragment content ranges from 11 to 94 %. Most rock fragment are ophiolitic in origin, including serpentinites and occasional magmatic and volcanic rock fragments. These forms angular coarse grains. However, sedimentary clasts are more rounded. Carbonat is the principal cementing materialand is predominantly sparry. The subordinate siliceous cement comprises mainly interstitial chalcedonic infills. Olivine, pyroxene, chlorite, biotite, muscovite and iron oxides have been identified in heavy mineral seperations from these sandstones. Corrensite, illite and cholorite have been identified within the clay matrix. The corrensite is richer in illite than chlorite [7].

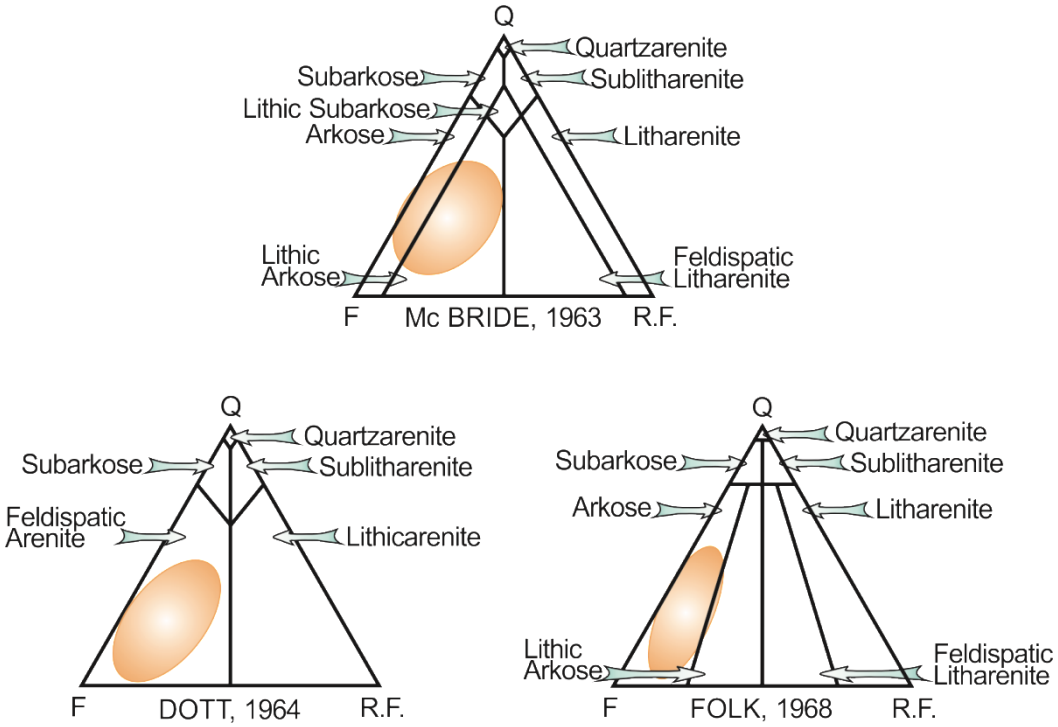

Figure 4: Petrographical classification of the Bozbel Formation sand stones [7-10]

Using the classification schemes of[8]or [9]most of Lutetian Bozbel Formation sandstones are arkoses or lithic arkoses, with feldspar dominant, rock fragments abundant and quartz in relatively small amounts. A small number of coarser sandstones fall in the feldspathic litharenite field while a few matrix-rich sandstones can be termed feldspadhic wackes, on the classification of [10].

Under appropriate conditions, it is possible to utilise the relative proportions of the major dertial components of sandstones to deduce the geotectonic nature of the source-areas supplying the detritus. Using this approach, three broad types of provenance field can be distinquished, using the relative abundances of quartz, feldspar and rock fragments (lithics) on a cement and matrix–free basis (Figure 5a). A more detailed assessment of provenance can be achieved by further sub-division of the mineral and lithic components (Figure 5b and c). On this basis, the relevant data for he analysed Bozbel Formation sandstones are illustrated in Figure 5 and Figure 6[11-12]. Most of these samples plot in the magmatic and mixed arc provenance areas of the QFL QmFLt diagrams (Figure5a and b), and fall in the arc orogen source area in the QpLvLs triangular diagram (Figur 5c). The Bozbel sandstones plot in the dissected arc and transitional arc segments of both the QtFL diagram (Figure 6a) and the QmFLt diagram (Figure 6b).

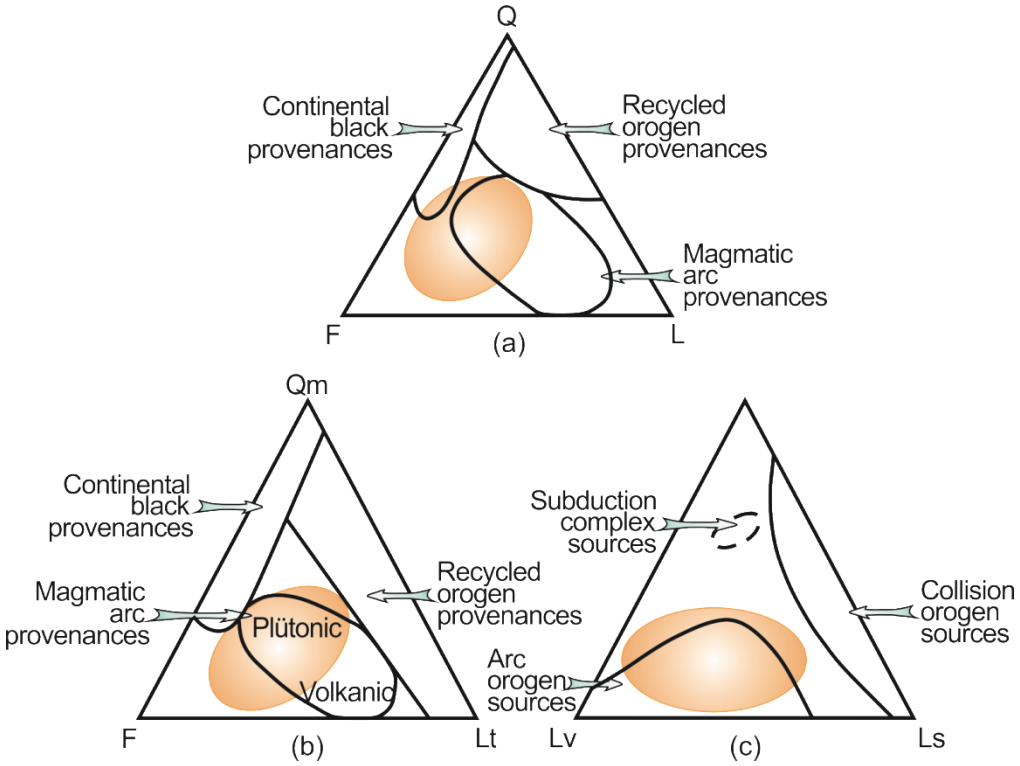

Figure 5. Tectonosedimentary classification of the investigated area sandstones[7-11-12]

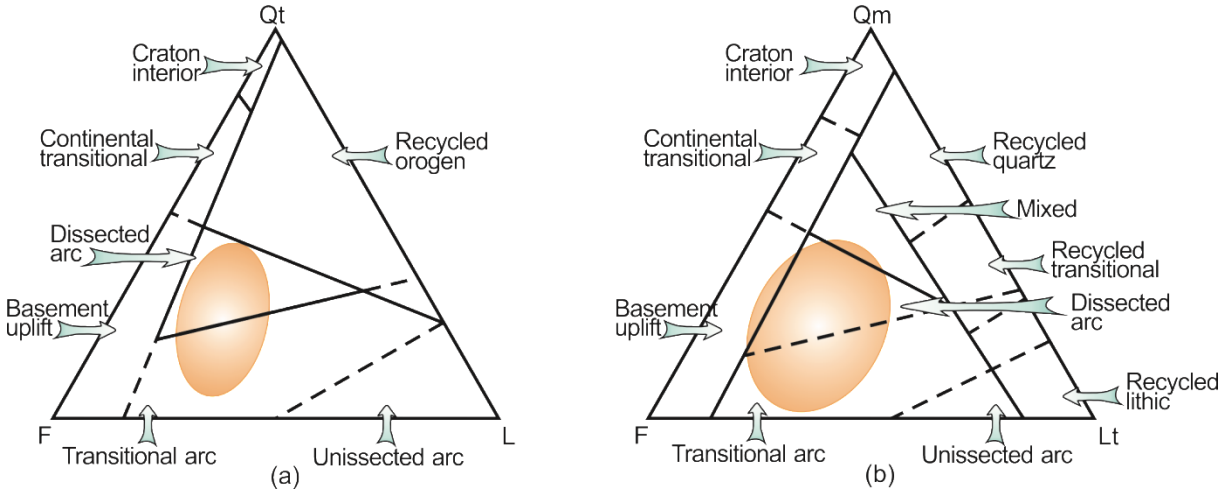

Figure 6: Transitional provenance diagrams for the Bozbel Formation sandstones [7-11-12]

This deductions concerning the provenance of the Bozbel Formation turbitides are fully compatible with the general geological framework of these deposites. The Lutetian sandstones contain magmatic clasts derived from the obducted ophiolitic slices that form part of the basement of the basin, demonstrating uplift and reworking of this magmatic material during early Cenozoic time [7].

Conclusions

Seven vertical lithological sections, namely the Bozbel Formation (Lutetian), were measured from different locations and samples were obtained for petrographic analysis. The sandstones (turbidite) of the Bozbel Formation are deficient in quartz but dominated by plagioclase feldspar and lithic clasts of the ophiolitic origin.

Most can be classified as arkoses, lithic arkoses and feldspathic litharenites, but some are slightly reworked tuffites. These sands were derived mainly from magmatic arc sources, a conclusion which is also supported by the assemblages of clay minerals and the ferromagnesian-rich heavy mineral separations obtained the sands.

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