13. CORRELATION OF BLACK SEA SEQUENCES

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Although the Black Sea sites, especially Sites 379 and 380, were located at considerable distances apart, many correlatable horizons have been recognized. Different categories of criteria for time correlation have been applied, they are

- Palynology (climatic indicators)
  - Pollen diagram, expressed in "steppe index"
  - Pollen assemblages
- Other fossils (salinity indicators)
  - Nannofossils
  - Diatoms
  - Dinoflagellate "19-20"
  - Benthic foraminifers
- Isochronous lithological changes
  - Coarse clastics of unusual significance
  - Chemical sediments, calcite, aragonite, dolomite, siderite.

Various marker horizons were recognized. The basis for correlation is discussed in detail in the following sections.

PALYNOLOGY (CLIMATIC INDICATORS)

Pollen are good indicators of past climates. Where climatic changes are isochronous, pollen assemblages yield useful information for time correlation. Of two basic approaches, one is to compare profiles of continuous climatic fluctuations from two sites; the other is to compare the nature of floral assemblages themselves. Both methods have been attempted in correlating the Black Sea sections.

Steppe Indices

The steppe indices, used by the shipboard palynologist, A. Traverse, to express diagrammatically the oscillating climatic changes of the Black Sea region, are the percentage of pollen grains derived from steppe vegetations in a total assemblage, or

$$\text{S.I.}_{\text{complete}} = \frac{\text{Steppe Pollens}}{\text{Steppe Pollens} + \text{Forest Pollens}} \times 100$$

A complete steppe index takes into consideration all of the pollen grains counted in a slide. In the Site 379 cores and in the upper 850 meters of Site 380 cores, the main steppe indicators are pollen of *Artemisia* and *Chenopodiaceae*, and the main forest indicators are those of *Pinus*, *Abies*, and *Quercus*. For this reason, a simple steppe index was calculated based upon those five pollen only, or

$$\text{S.I.}_{\text{simple}} = \frac{\textit{Artemisia} + \textit{Chenopodiaceae}}{\textit{Artemisia} + \textit{Chenopodiaceae} + \textit{Pinus} + \textit{Abies} + \textit{Quercus}} \times 100$$

Both complete and simple indices for Sites 379 and 380 have been computed by the shipboard staff on the basis of Traverse's investigations of core-catcher samples; the simple indices, on the whole, are found to be not much different from the complete indices (see Traverse, this volume). Our calculation, as shown in Figure 1, is based upon the simple indices, which were the only ones available to us when the correlation had to be made. We noted, however, the possibility that *Artemisia* and *Chenopodiaceae* pollen grains may have been preferentially destroyed near the bottom of Hole 379A. For that part (below 400 m subbottom) of the sequence, the complete S.I. has appreciably higher values than the simple S.I., and should be better climatic indicators.

In order to eliminate immaterial short interludes of oscillations, the steppe index can also be expressed by a curve of sliding averages. There is, however, a danger that five-point sliding averages may eliminate some short interludes of *real* changes and therefore the sliding-average diagrams are consulted only to gain an insight into the overall climatic changes. The sliding averages of complete steppe indices, as calculated by Traverse (this volume), are shown in Figures 1 and 2. Sites 379 and 380 indicate three broad maxima of steppe indices, which are taken as indicators of three major periods of glaciation. Since the correlation with the Alpine glacial stages and with those in northwestern Europe is uncertain, a set of new names has been given to the glacial stages as recorded by the Black Sea sediments. They are, from the oldest to the youngest, Alpha, Beta, Gamma (Traverse, this volume). The two interglacial stages are Anna and Betty, or simply A and B.

The shape of the sliding average curves for the two sites is not exactly identical; the difference is probably related to sedimentation rates. The glacial maximum Alpha at Site 380 is much broader than that at Site 379, because the Alpha sediments at Site 380 include considerable slump deposits accumulated at a fast rate. In contrast, the glacial maxima Beta and Gamma are broader at Site 379, where the middle and late Quaternary sediments were deposited at a faster rate than those at Site 380. It is noteworthy that Interglacial A may have been of longer duration and warmer than Interglacial B, although the latter is not very well defined at Site 379. Although the shipboard scientists agreed on the correlation of the Gamma and Beta stages, there is some question of whether the Alpha stage in Hole 380 is equivalent to the Alpha stage in Hole 379, because siderite is present in one but not in the other. Traverse (this volume) and I believe that the Alpha glacial maxima in the two holes are true equivalents because the correlation is supported by other floral evidence (unusual abundances of fresh-

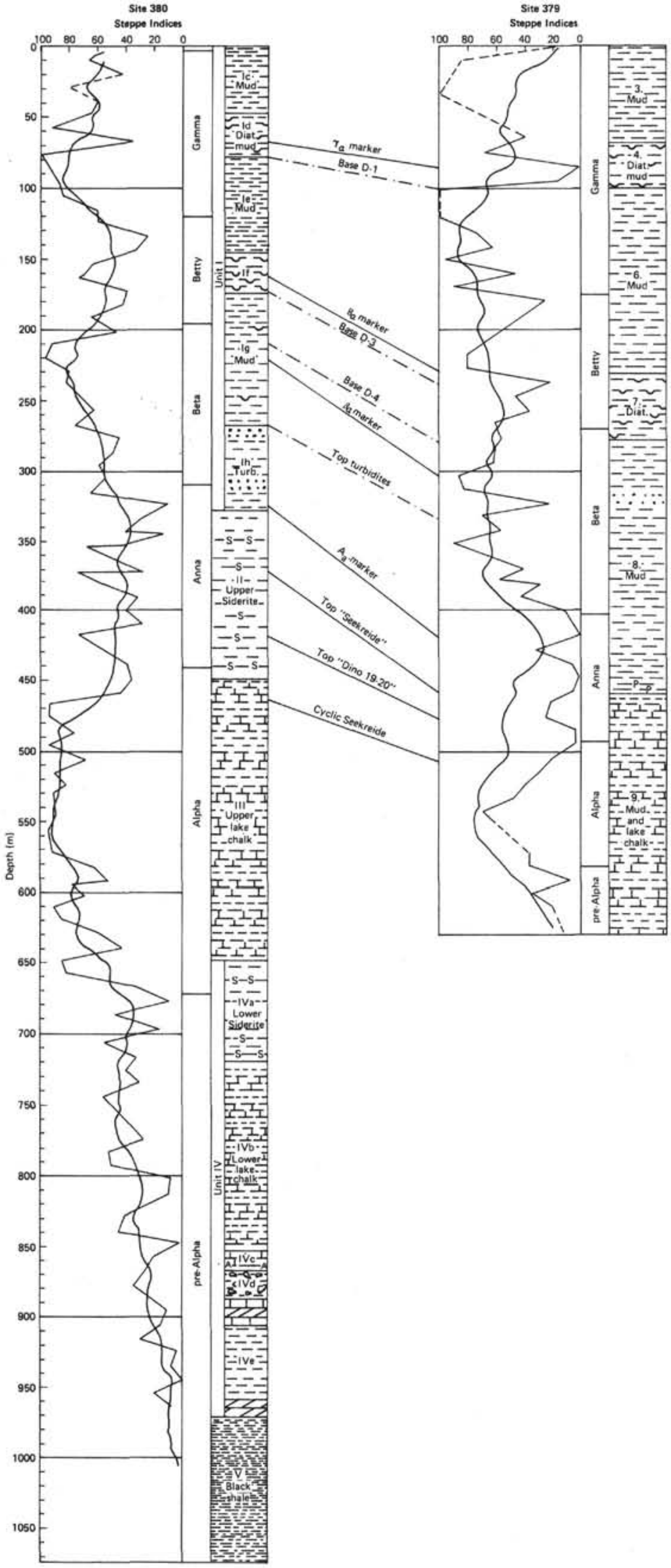

Figure 1. *Chronostratigraphic correlation of Sites 379 and 380. Markers indicative of isochronous climatic changes based upon the variation of steppe index (simple). Also shown are curves*

of the five-point averages of steppe index (complete). Glacial stages Alpha, Beta, and Gamma, and interglacial stages A and B have been defined on the basis of those sinous curves. Markers indicative of isochronous salinity changes based upon the occurrence of diatoms are D-1, D-3, D-4, and "Top Dinoflagellate *19-20" (major occurrence). Markers indicative of isochronous lithologic changes are the "Top turbidite," "Top* Seekreide,*" and "Cyclic* Seekreide,*"(notable occurrence). The nine correlative markers are subparallel. The correlations indicate that the chemical sediments (Units II and III and their equivalent) were accumulated at a faster rate at Site 380 closer to the Black Sea margin, and the terrigenous sediments (Unit I and its equivalent) were accumulated at a faster rate at the basin center Site 379.*

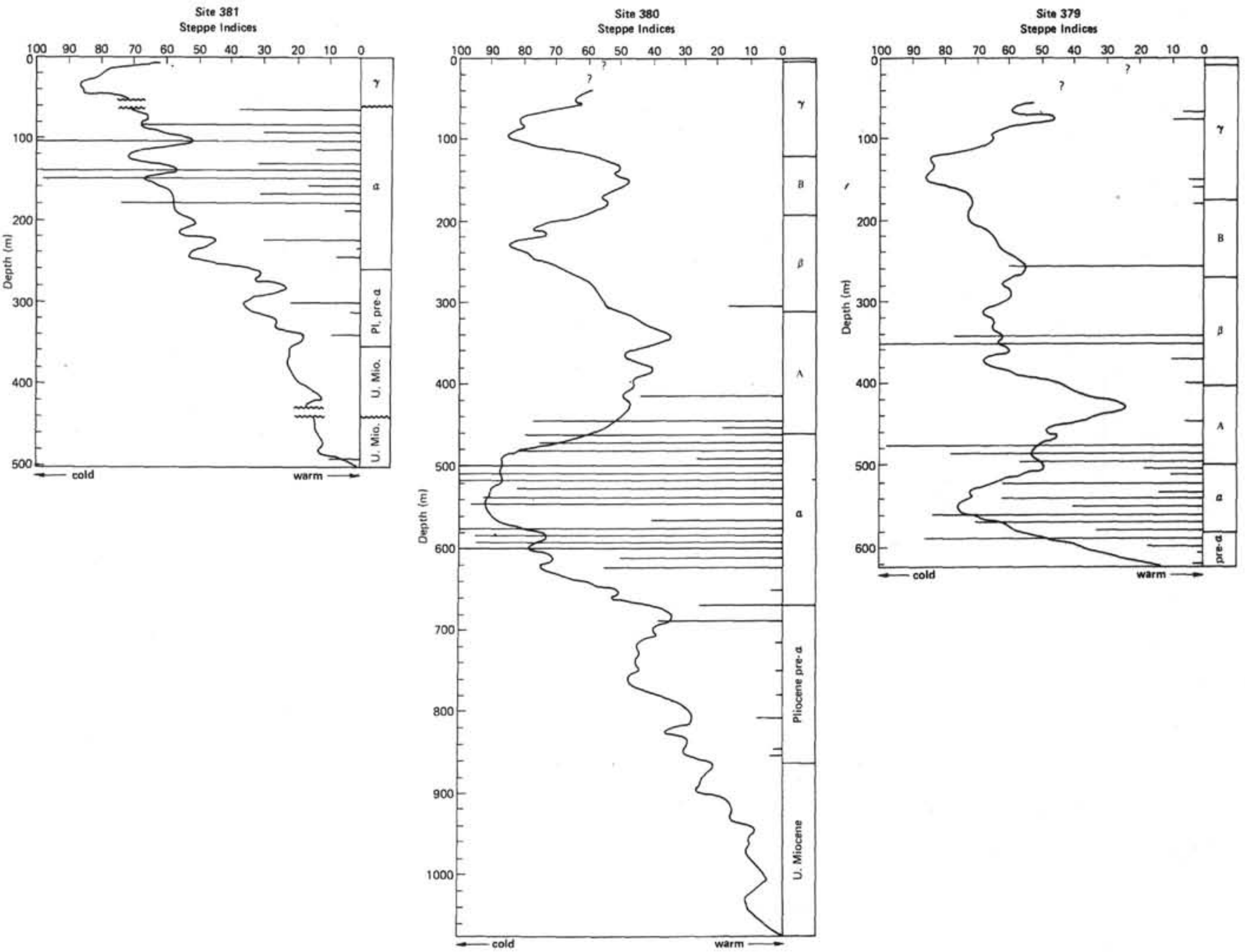

Figure 2. *Correlation of paleoclimatic records at three Black Sea sites (after Traverse, this volume). Variations of the curves of five-point sliding averages of Steppe Index (complete) permit the recognition of Glacial Stages α, β, γ, and interglacial stages A and B at Sites 379 and 380. The paleoclimatic record at 381 is incomplete because of slumping after the sedimentation of lacustrine chalk* (seekreide). *Also shown are the abundance of "Dinoflagellate 19-20" expressed by horizontal bars representing the percentage of*

$$\frac{\text{"Dinoflagellate 19-20"}}{\text{All Dinoflagellates and Acritarchs}}$$

The "Dinoflagellate 19-20" is particularly abundant in chalks (seekreide *) which were deposited when the Black Sea was a deep freshwater lake during the glacial stage Alpha.*

water dinoflagellates in the Alpha sediments) and by isochronous lithological changes (cessation of lacustrine chalk deposition at or near the end of the Alpha time). We shall discuss this question at some length in a later section.

The S.I. sliding average curve of Site 381 clearly shows the passage from a warm to a glacial climate during the Pliocene and Early Quaternary. Because correlation of isochronous lithologic units indicate a major discordance between the sediments deposited during the Glacial Stage Alpha and those of the Gamma, we were unable to obtain a complete Quaternary climatic record at this site.

For more exact correlation we can turn to the variation of individual values of the steppe indices. The S.I. (simple) for both Sites 379 and 380 are shown in Figure 1. At Site 379, alternating conditions of predominating steppe and forest vegetations, or oscillating cold and warm climates, were found in all of the cores down to 600 meters in Hole 379A. At Site 380, only the upper 700 meters show an oscillating climate between the two end members. Below 700 meters the forest pollen constitute at least 40% to 50% and, below 850 meters, more than 70% of the whole; an analysis of the total pollen assemblages must thus be relied upon to provide an interpretation of the changing climates. No simple steppe index was calculated for cores at Site 380 below 1000 meters.

Correlation of the oscillating valleys and peaks of the steppe indices indicates four chronostratigraphic markers, namely γ_a, Bα, $\beta\alpha$, and A_a

A most prominent marker near the top of the Quaternary, is the γ_a marker (Figure 1). At this horizon the steppe index plunges almost to zero at Site 379, and to 37 at Site 380 before it rises again to 100 down section.

The γ_a marker signifies a warm interlude, but its duration was so short that it did not find an explicit expression on the sliding average diagrams (Figure 2). Since the main glacial and interglacial stages are defined by maxima and minima on the sinuous curve of five-point averages, the γ_a interlude is considered to have been an interstadial episode within the Glacial Stage Gamma. It has been suggested by others that it should be correlated to the Eemian Interglacial of North Europe or to the Riss-Würm of Central Europe (Degens, et al., this volume; Koroneva and Kartashova, this volume).

Other prominent markers are:

$\beta\alpha$ marker, marking a cold episode in the middle of Interglacial Stage B.

$\beta\alpha$ marker, marking the zenith of Glacial Stage Beta.

A_a marker, marking the last optimum warm episode of the Interglacial Stage A.

Pollen Assemblages

Changes of pollen assemblages in response to the gradual cooling of Europe during the late Neogene may serve as a basis for correlation. The extinction of the warm, upland *Engelhardia* flora in northwestern Europe was believed to be a late Miocene event (some 7.5 m.y., according to van der Hammen, et al., 1975). We might assume that the extinction of this flora is isochronous for the regions around the Black Sea, even if it is a diachronous in relation to northwestern Europe. This assumption permits a correlation of the lowest units at Site 381 (Units 7, 8, and 9) to the very bottom core (380A-80) at Site 380. The common occurrences of *Tsuga* (hemlock), of conifer pollen, and of *Ulmaceae* (elm), combined with other evidence, indicate an approximate correlation of the lowest cores (62-68) of Hole 379A to Cores 36-41 of Hole 380A (Traverse, this volume). I suggest that we place the top of pre-Alpha datum at about 577 meters in Hole 379A and 670 meters in Hole 380A (Figure 1). Below the datum, the S.I. (complete) sliding averages fall below 50. The marker also signifies the end of a very warm, short interlude characterized by a low steppe index of less than 10 (Figure 1).

OTHER FOSSILS (SALINITY INDICATORS)

Studies of Black Sea piston cores have shown that Holocene changes in salinity in the Black Sea were isochronous events, relating to the worldwide eustatic changes (Degens and Ross, 1974). At low stands of worldwide sea level, the Black Sea was a fresh-water lake isolated from the Mediterranean. At high stands, such as present day, a connection to the open sea is established, and the Black Sea is brackish. Deep Sea Drilling cores show that there have been repeated changes in the depositional environments of the Black Sea; nannofossils and diatoms indicate several marine incursions when the Black Sea became brackish marine. Since those events must have been geologically instantaneous, horizons of abrupt salinity changes, as indicated by floral ecology, can be considered chronostratigraphical markers.

Nannofossils

Three types of nannoflora were recognized: (1) an *Emiliania huxleyi* flora, (2) an *Emiliania huxleyi-Gephyrocapsa caribbeanica* flora, and (3) a *Braarudosphaera bigelowi* flora. The occurrence of these nannofloras indicates episodes when seawater entered the Black Sea, rendering its water brackish marine.

The floras themselves do not necessarily serve as correlative markers. For example, the *Braarudosphaera* occurrence in Core 379A-25 cannot be correlative to the one in Core 380A-35, but the correlation of the *Emiliana-Gephyrocapsa* flora in Unit 4 at Site 379 to that in Unit I_d at Site 380 is established by various other lines of evidence: the correlation is parallel to the γ_a marker established on the basis of pollen diagrams and to the D-1 marker established on the basis of diatom occurrences (Figure 1). Similarly, the occurrence of the *Braarudosphaera* flora in Unit 5 at Site 381 is evidently a correlative to that in Unit IV_c at Site 380; the flora occurs above a remarkable unit of coarse-clastic sediments (Units IV_d at Site 380 and 6 at Site 381), which are believed to have been deposited isochronously.

Diatoms

Diatoms are salinity indicators; both marine-brackish and freshwater species have been identified from the Black Sea cores.

Six diatom-bearing intervals were recognized within Unit I in Hole 380, namely

D-1 15-76 m, Cores 5-8, Unit I_d
D-2 94-114.5 m, Cores 11, Unit I_e
D-3 142.5-171 m, Cores 16-18, Unit I_f
D-4 199.5-209 m, Core 22, Unit I_g
D-5 294.5-304 m, Core 32, Unit I_h
D-6 323-332.5 m, Core 35, Unit I_i

Three of the intervals are representative by correlative horizons in Hole 379A, (see Figure 1), namely

Marine-brackish diatoms in Unit 4, 379, correlative to D-1, Unit I_d, 380

Marine-brackish diatoms in Unit 7, 379, correlative to D-3, Unit I_f, 380.

Freshwater-brackish diatoms in Core 29, correlative to D-4, Unit I_g, 380.

The marine-brackish D-2, and D-6, both accompanied by a *Braarudosphaera* flora, and the fresh-brackish D-5 horizons in Hole 380 were not identified at Site 379. The lack of correlation may be related to incomplete core recovery or to poor preservation of fossils at Site 379.

Diatom occurrences also aided in the correlation of Sites 380 and 381; the freshwater-brackish assemblages in Unit III, Site 380, are correlative to those in Unit 1, Site 381, and the marine-brackish assemblages in Unit IVb and IVc are correlative to those in Units 4 and 5, Site 381.

Dinoflagellates

Dinoflagellates commonly occur in the Black Sea sediments deposited in brackish-marine environment. Traverse (this volume) introduced the concept of "Marine Influence Index" (MI) calculated to be the following ratio:

$$\text{M.I.} = \frac{\text{Dinoflagellates + Acritarchs}}{\text{Dinoflagellates + Acritarchs + total Pollen}}$$

Traverse's index is in places misleading because a bag-like dinoflagellate (as yet unnamed "Dinoflagellate 19-20") occurs abundantly in cores containing a freshwater ostracode fauna (e.g., Cores 380A-14-23) and in cores containing the same fauna plus a freshwater diatom flora (Cores 380A-26-32). "Dinoflagellate 19-20" was thus, most probably, a freshwater creature, and seemed to have flourished at times of lacustrine chalk (*seekreide*) deposition. Its occurrence became more sporadic toward the top of the sequence of chemical sediments at Site 380, and is rarely found above Sample 380-39, CC (or 380A-3, CC) in the transition zone to turbidite sedimentation (Unit I_h). In Hole 379A the last major occurrence of "Dinoflagellate 19-20" is recorded in Sample 379A-51, CC, in the same transition between a predominately *seekreide* (lower part of Unit 9) and a turbidite sequence (Unit 8). Tentatively, I suggest a correlation of the uppermost occurrence of "Dinoflagellate 19-20," to mark the end of a long period of lacustrine chemical sedimentation (see Figure 1); other evidence for such a correlation will be discussed in a following section.

Benthic Foraminifers

The *Ammonia becarrii* fauna is commonly in association with the nannoflora *Braadurosphaera*; the fauna occurs in correlative marine-brackish units of Sites 380 and 381. The lower cores at Sites 380 and 381 contain benthic foraminifer assemblages comparable to the Paratethys upper Miocene sections on land. Gheorghian (this volume) makes a tentative stratigraphical correlation, and his conclusion is in agreement with conclusions based upon other criteria (lithology, pollen, etc.).

ISOCHRONOUS LITHOLOGICAL CHANGES

Chemical sedimentation played an important role in the Black Sea prior to the predominately terrigenous sedimentation in the Quaternary. Obviously, the nature of chemical sediments precipitated is dependent upon water chemistry which is dependent upon the evaporative history when the basin was landlocked, and upon the degree of open-marine influence when the basin was connected to the Mediterranean. One would expect that the chemistry should be more or less the same over large parts of the open waters at any given time. The end of chemical sedimentation most likely was an isochronous event, relating to a major change of drainage which, in turn, resulted in a vastly greater influx of detritus into the Black Sea Basin. This line of reasoning leads to the belief that the base of Unit I at Site 380 is a correlative horizon to the base of Unit 8 at Site 379 (Figures 1 and 3). Further, the first occurrences of aragonite at 855 meters in Hole 380A and at 351.5 meters in Hole 381, are undoubtedly related to marine incursions (Figure 3); aragonite being the metastable calcium-carbonate precipitate in seawater, or in waters rich in Mg-ions which tend to hinder the nucleation of calcite crystals. The first occurrence of aragonite follows the last occurrence of authigenic dolomite; this event marks the sudden flooding of a shallow-water Black Sea, which ended supratidal dolomitization and started aragonite precipitation.

The last occurrence of *seekreide* (lacustrine chalk) seems to be a gradual event. *Seekreide* intercalations are common in Unit III of Site 380 and in the middle part of Unit 9 of Site 379 where they form cyclic deposits two to eight cm thick. Particularly well developed cyclic sequences of *seekreide* are in Core 380A-12 (462 m) and in Core 379-55 (505 m); the horizons mark the change from Glacial Stage Alpha to Interglacial Stage A, and are believed to be isochronous (Figure 1). The *seekreide* is less common in Unit 2 of Site 380 and the upper part of Unit 9 of Site 379. The youngest *seekreide* of Unit II occurs in Section 380-39-6 (370 m), and the youngest of Unit 9 in Core 379A-50 (455 m). These levels are slightly above the highest occurrence of freshwater "Dinoflagellate 19-20" and probably represent an isochronous change of water chemistry, which terminated the condition of *seekreide* deposition (Figure 1).

The significance of siderite occurrence is a controversial problem. It occurs in Unit IV_a at Site 380 and in Unit 3 at 381 which are close to each other and may be correlative events; it is also present in Unit II at

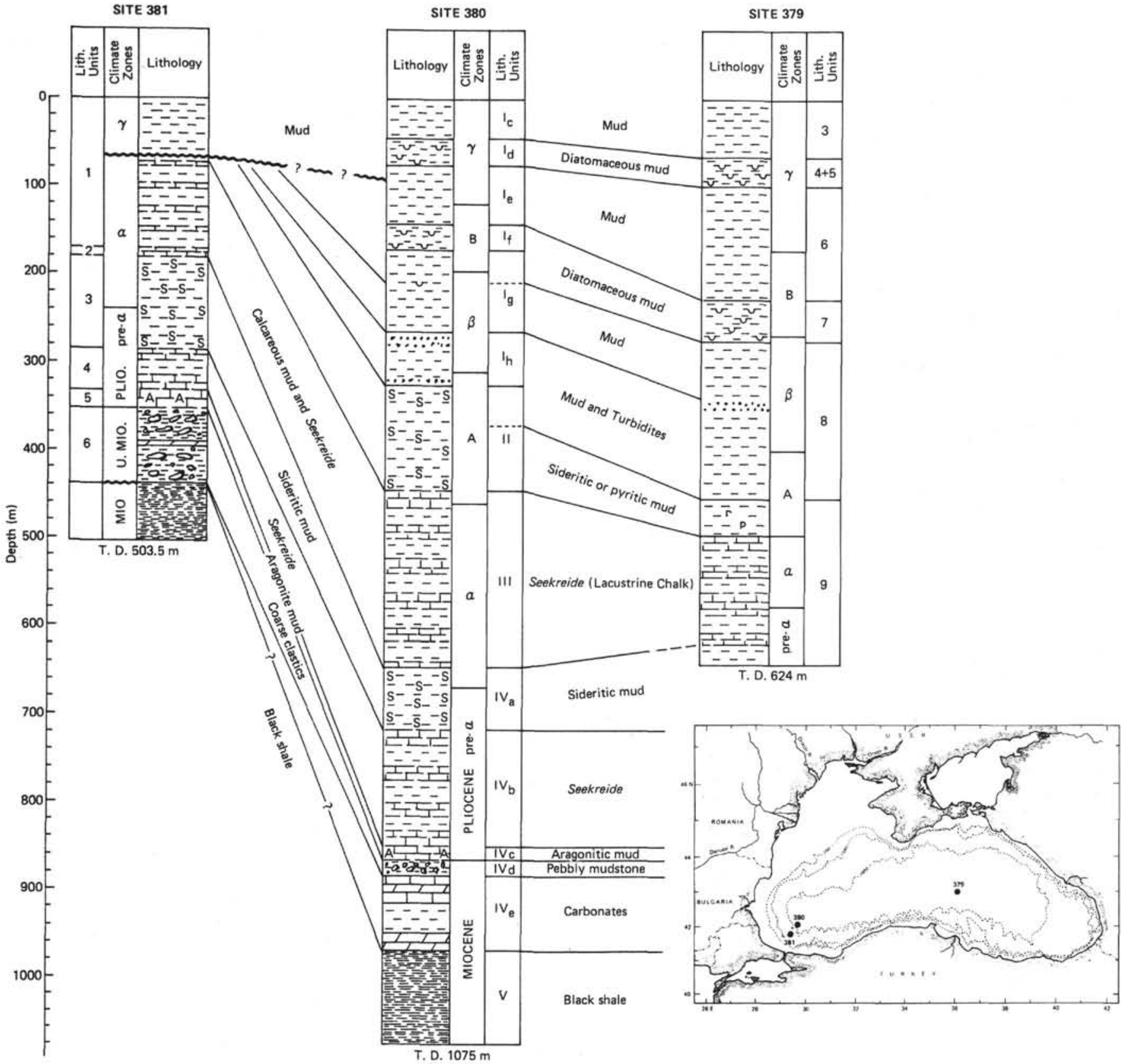

Figure 3. *Correlation of lithologic units at three Black Sea sites. Lithologic changes were related to changes in salinity, water-chemistry, climate, and terrigenous influx. Since those changes, on the whole, influenced the Black Sea sedimentation isochronously, most correlative lithologic units are believed to be isochronous. The notable exception is the correlation of sideritic mud (Unit II, Site 380), with pyritic mud (upper part of Unit 9, Site 379).*

Site 380. The absence of siderite in the basin center in Hole 379A can be interpreted variously (see Degens and Stoffers, this volume).

"Pebbly mudstone" units at Sites 380 and 381 are probably correlative. Those coarse clastics and the intercalated stromatolitic dolomite accumulated during an unusual episode in the history of Black Sea sedimentation, when there was a major lowering of water-level in the basin (see Hsü, this volume). Such an event would have left an isochronous lithology in the sedimentary record.

CORRELATION OF LITHOLOGIC UNITS

The stratigraphical correlation of the three Black Sea sites are shown diagrammatically in Figure 4. The equivalent units are:

	II
I_a and I_b at Site 380	1 and 2 at Site 379
I_c mud	3 at Site 379
I_d diatomaceous mud	4 and 5 at Site 379
I_e, I_f, and I_g (upper) mud	6 and 7 at Site 379
I_g (lower) and I_h mud and turbidite	8 at Site 379
II upper siderite	9 (upper 1/3), at Site 379
III upper *seekreide*	9 (lower 2/3) at Site 379 and 1 (lower) and 2 at Site 381
IV_a lower siderite	3 at Site 381
IV_b lower *seekreide*	4 at Site 381
IV_c aragonite	5 at Site 381
IV_d coarse clastic	6 at Site 381
IV_e carbonates	missing
V black shale	7, 8, 9 at Site 381

The above correlation has been agreed upon by other shipboard sedimentologists with the exception of Units II and V at Site 380 to those at Sites 379 and 381. My conclusions are based on the following considerations:

Unit II at Site 380 is characterized by numerous intercalations of carbonate-rich layers in a predominately mud sequence. It underlies the mud and turbidite Unit I_h. The sediments below the correlative terrigenous Unit 8 at Site 379 is Unit 9, which is also a mud sequence with numerous intercalations of carbonate-rich layers. I recognize the considerable difference in lithology and in fossil content between Unit II and Unit 9. The Unit II at Site 380 includes not only calcite-rich layers, which are present in Unit 9 of Site 379, but also numerous siderite-rich layers, which are absent at Site 379. In addition, the presence of marine-brackish diatoms at several horizons, and the occurrence of a *Braarudosphaera* flora at the top of the Unit II indicates influx of marine waters; those floras have not been found in Unit 9 at Site 379. Degens and Stoffers (this volume), therefore, postulated that the sediments correlative in age to Unit 9 have been removed by slumping at Site 380; they speculated that the sediments isochronous to Unit II lie below Unit 9, and that they have not been penetrated by drilling at Site 379. I differ from their interpretation and propose a correlation of Unit II at Site 380 to the upper part, and of Unit III to the lower part of Unit 9 at Site 379. This correlation was made because:

1) Pollen diagrams show that Unit II at Site 380 and Unit 9 at Site 379 were deposited when the climate was warm and temperate with some cold interruptions in a period designated by us as Interglacial Stage Anna (Figure 1).

2) Ecological considerations indicate that the freshwater deposition which prevailed in the Black Sea basin for 2 or 3 million years were interrupted by marine influx during the time when Unit II and upper Unit 9 were deposited. The change was probably responsible for the disappearance of the freshwater Dinoflagellate "19-20" and for the termination of periodic *seekreide* sedimentation, at correlative horizons of both sites (Figure 2).

3) Unit III at Site 380 is remarkably similar in lithology and in genesis to the lower part of Unit 9 at Site 379. Both sequences are characterized by cyclically deposited *seekreide*, deposited in a mainly freshwater environment. Figure 4 shows particularly representative cycles in Core 58 at Site 379 and Core 14 at Site 380.

4) Deuser (This Volume) found a steady temporal change of the δo^{18} of the Black Sea sediments. The value changes upward at Site 380 from about minus 1 in Unit IV_e (at about 860 m) to about minus 5.5 or 6 in Unit III (at about 450 m). This change took place during the course of 2 or 3 million years as a result of steady freshening of the Black Sea waters by the river influx.The freshwater condition terminated sometime during the deposition of Unit II with the influx of saline water, as suggested by faunal, floral, and isotopic evidence. Our isotopic analyses of the cyclically deposited *seekreide* at two sites yielded almost identical δo^{18} values (Table 1). The results, according to our model, confirm the interpretation that the Black Sea had evolved to about the same stage of freshening when these *seekreide* (with δo^{18} values of minus 5.5) at both sites were deposited.

5) There is no direct evidence to support the postulate by Degens and Stoffers that sediments coeval to those of Unit 9 at Site 379 are missing, and that a discordance exists between Units I and II at Site 380; neither seismic, nor fossil record gives any hint of a missing section.

For those reasons, I believe that the upper part of Unit 9 at Site 379 is a facies equivalent of Unit II at Site 380 (Figure 3). Siderite is absent at the basin-center site, because the local chemical environment was not suitable for siderite formation. Also absent at Site 379 are brackish marine fossils. I noted instead pyrite-rich horizons in Cores 51, 53, 54, 55, and 56 at this site. Pyrite was formed when there was sufficient sulfate-ions being reduced by bacterial action into sulfide ions. Since the sulfate ions of the Black Sea waters were derived mainly from seawater influx, the occurrence of appreciable pyrite in Black Sea cores has been considered indicators of marine-brackish conditions (Calvert and Batchelor, this volume). The absence of marine-brackish fossils in Site 379 cores may thus be attributed to calcite- and silica-dissolution. To summarize, we may regard Unit II at Site 380 and the upper part of Unit 9 at Site 379 as time equivalent, deposited during a transitional interval when *seekreide* sedimentation began to cease, and when terrigenous sedimentation became dominant in the Black Sea.

A second difficulty in correlation pertains to the sediments below the "pebbly mudstone." No sediments similar to Unit IV_e of Site 380 are present at Site 381. A

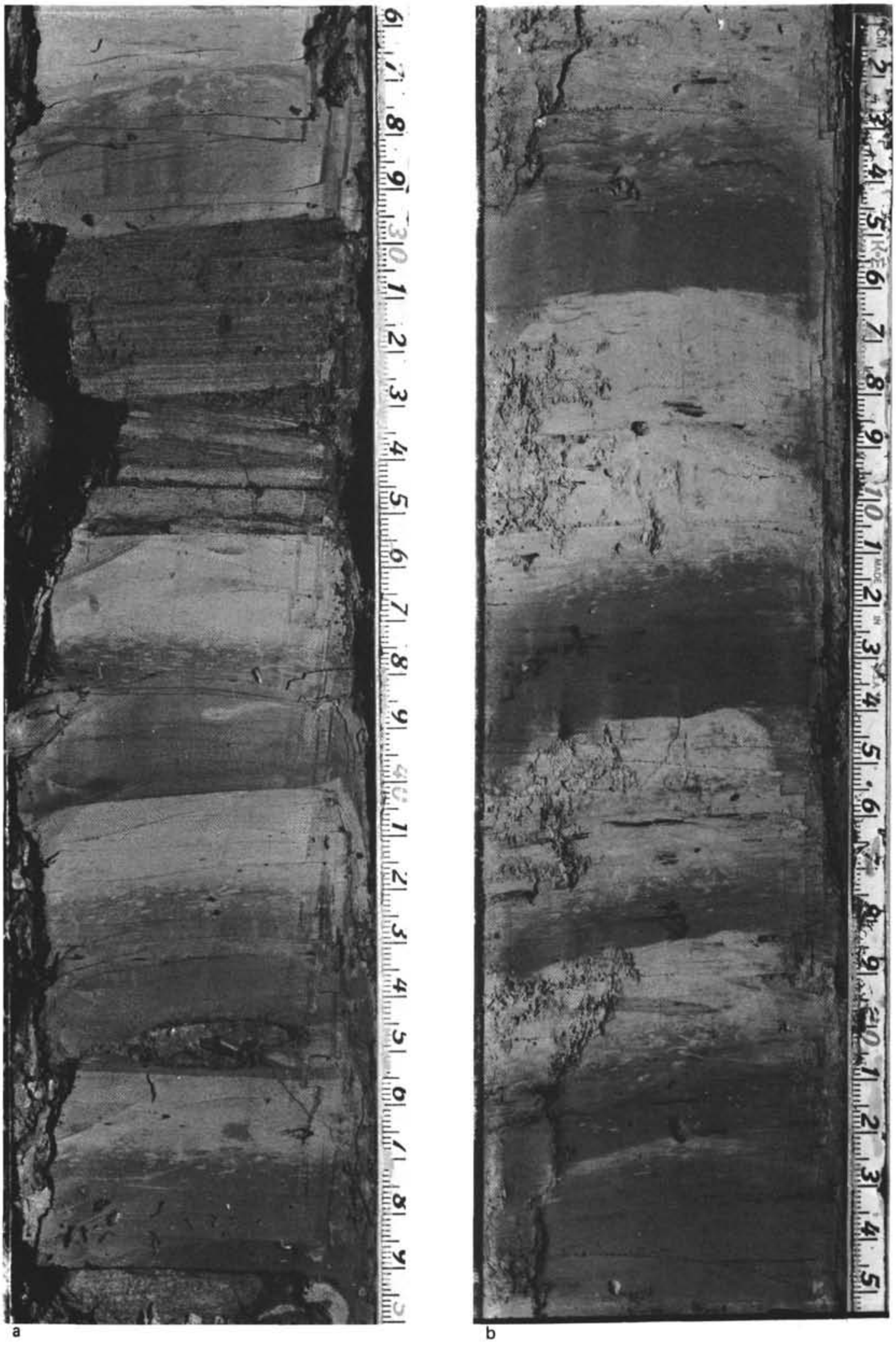

Figure 4. *Comparison of cyclically deposited* seekreide *(lacustrine chalk) from Holes 379A and 380A. Sections 379A-58-4 (a) and 380A-14-3 (b) consist of cyclically deposited* seekreide. *Cyclic layers 2 to 8 cm thick, are marked by sharp lower and upper contacts. The lower half is dark gray and terrigenous marl or mud and is separated from the upper calcite-rich* seekreide *by a zone of bioturbation (chondrites). The cycles are believed to reflect cyclic climatic changes around the Black Sea, which led to periodic deposition of lacustrine chalk in a deep freshwater lake. The cyclic deposits of the two sites were found in approximately equivalent stratigraphic horizons (near the end of Alpha glacial stage), and may have been deposited at the same time.*

tentative correlation of the Units 6, 7, and 8 to the bottommost part of Unit V at Site 380 is suggested by the occurrence of *Engelhardia* (see Traverse, this volume) and by the rather fragmentary foraminifera evidence (see Gheorghian, this volume).

SUMMARY

Chronostratigraphical correlation of lithological units from three Black Sea sites are possible because of (1) pollen, (2) other fossils, and (3) isochronous lithological changes. The shipboard scientists have reached consensus on the correlation of all but two units. The difficulty can be traced to possible facies variations of isochronous deposits. The suggested correlation is shown graphically by Figure 3.

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TABLE 1
Isotopic Composition of *Seekreide*
(analysis by J. McKenzie)

Sample (Interval in cm)	O^{18}_{PDB}	C^{13}_{PDB}
Hole 379A		
58-4, 27-28	–5.12	+2.22
58-4, 29-30	–5.57	+1.64
58-4, 30-31	–5.86	+0.64
58-4, 32.5-33.5	–6.22	–0.58
58-4, 38-39	–4.94	+1.60
58-4, 39.5-40.5	–5.34	+1.37
58-4, 41-42	–5.73	+0.00
58-4, 48-49	–5.20	+2.19
58-4, 50-51	–5.53	+0.57
Hole 380A		
14-3, 4-5	–5.46	+1.39
14-3, 5.5-6.5	–5.75	+1.39
14-3, 7.5-8.5	–5.52	+1.72
14-3, 9.5-10.5	–5.44	+2.18
14-3, 12.5-13.5	–5.19	+1.49
14-3, 14.5-15.5	–5.35	+1.96