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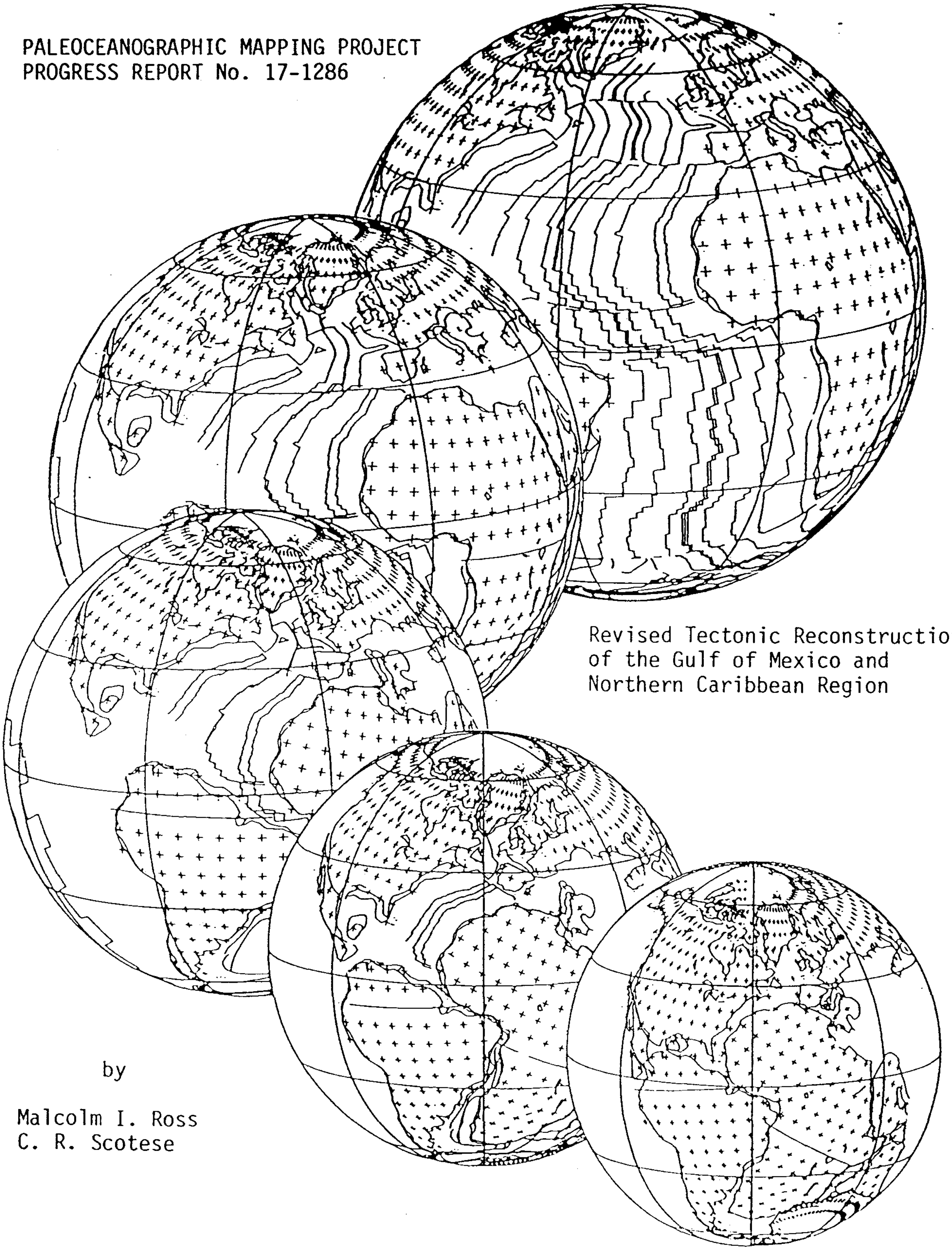
PALEOCEANOGRAPHIC MAPPING PROJECT
PROGRESS REPORT No. 17-1286



Revised Tectonic Reconstructions of the Gulf of Mexico and Northern Caribbean Region

by

Malcolm I. Ross
C. R. Scotese

University of Texas Institute for Geophysics Technical Report No. 64

Tectonic Reconstructions of the Gulf of Mexico and Northern Caribbean Region

Paleoceanographic Mapping Project Report #17-0187

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Abstract

Using the Pindell and Barrett (1987, in press) model for the evolution of the Caribbean as a starting point, we present 14 plate reconstructions (and a color animation) illustrating the evolution of the Caribbean region for the period 175 to 0 Ma. The new aspects of these maps are the result of:
1) Utilization of the Evans and Sutherland PS300 interactive 3-D color graphics display computer to project color-coded tectonic elements onto a spherical surface and to quantify the rotation parameters;
2) Subdivision of complex plate boundary zones into small rigid blocks;
3) Incorporation of results from recent Univ. of Texas Caribbean studies of the Yucatan Basin, Cayman Trough, Colombian Basin, Panama, Hispaniola, and Puerto Rico;
5) Incorporation of lithofacies and lithologic assemblages from the University of Chicago paleogeographic data base;
6) Use of the new model (Klitgord and Schouten, 1986) for the evolution of the North, Central and Southern Atlantic Oceans;
7) Assumption that the basement of Cuba is the same as stable Bahamas Platform;
8) Palinspastic restoration of the volume of the Gulf of Mexico and the North American continental margin based on total tectonic subsidence model of Dunbar and Sawyer (1986);
9) Juxtaposition of Demerara Plateau and Guinea Plateau to constrain northern South American - central African fit.

The reconstructions presented here are modified after Pindell and Barrett (1987, in press). We consider the following features to be major improvements:

1) All areas/blocks that have moved independently ("Terranes", sensu strictu) are herein termed "tectonic elements" and are treated as rigid blocks. Complex regions that show evidence of non-rigid deformation (i.e. change of shape) are broken up into several small rigid tectonic elements which move independently, thereby preserving volume (to a first approximation) but allowing the overall shape of the region to change.

2) For selected time intervals (Table 1) the position of each tectonic element has been described in terms of a finite pole of rotation. All recostructions are calculated in 3-dimensions then projected back to 2-demensions, thereby avoiding any distortions implicit in reconstructions done by "cutting and pasting" map projections. Reconstructions for any other time can then be produced by interpolating between these time intervals.

Table 1 : Caribbean Reconstruction Times:

1.	0.0	AN 1	Present
2.	10.6	AN 5	Late Miocene
3.	20.5	AN 6	Early Miocene
4.	35.9	AN 13	Early Oligocene
5.	44.1	AN 19	Late Eocene
6.	50.3	AN 21	Middle Eocene
7.	59.2	AN 25	Late Paleocene
8.	72.0	AN 32	late Campanian
9.	84.0	KQZ	mid-Campanian
10.	100.0	KQZ	late Albian
11.	118.7	M 0	early Aptian
12.	143.8	M 19	Tithonian
13.	160.0	M 29	Oxfordian
14.	180.0	FIT	Middle Jurassic

3) Lithofacies distribution patterns and lithologic assemblages from the (Univ. of Chicago Paleogeographic Atlas Project) were plotted on for six reconstructions (Recent, Chattian, Lutetian, Maestrichtian, Aptian, and Callovian). These data were rotated with their associated tectonic elements. Facies changes and offsets in the facies patterns provided additional constraints for the reconstruction.

4) The tectonic evolution of the Cayman Trough, which forms the strike-slip plate boundary between North America and the Caribbean, has been modelled by analysis of marine magnetic anomalies (Rosencrantz, Ross, and Sclater, in prep.) and depth to basement (Rosencrantz and Sclater, 1986). These studies have suggested that the Cayman Trough began to open in the latest middle Eocene (Anomaly 19, 44.1 Ma) and that spreading has continued at rates of 1.5 to 2.5 cm/yr since that time.

5) The relative positions of North America, South America, and Africa (Jurassic to Present) are based on the recent synthesis of magnetic data by Klitgord and Schouten

(DNAG, 1986). The movement of these major plates provides the kinematic framework for understanding the evolution of the Caribbean and Gulf of Mexico.

6) The basement of Cuba is considered to be the same as the basement of the Bahamas Platform. This basement has been overthrust by forearc materials that originated from the Cayman Ridge. The Yucatan Basin opened as an inter-arc basin between the Cuban thrust sheets and the Cayman Ridge. The inclusion of the Cuban basement provides a better Jurassic fit of the continents bordering the Gulf of Mexico (figure 1).

7) Volume of Gulf of Mexico is palinspatically restored using the total tectonic subsidence model of Dunbar and Sawyer (1986). In this study, the depth to basement was contoured and converted to what they felt was an accurate estimation of the degree of stretching. Pre-rift volume of the Gulf is restored by collapsing contours in proportion to the amount of stretching.

8) The reconstruction of North American and Africa prior to the opening of the central Atlantic is based on the fit of the palinspastically restored margin of the North America (Sawyer, 1984) with the shelf-slope break along the western margin of Africa.

9) Using reflection seismic data, Mascle et al (1986) identifed a volcanic plateau along the west-central margin of Africa (near equatorial Guinea). The plateau is Jurassic-Early Cretaceous in age and is bounded by a stretched margin on the west and a steeply faulted strike-slip margin on the south. The conjugate plateau on South America is the Demerara Plateau on the northeast coast of South America between Guyana and northern Brazil. The Demerara Plateau has a steeply faulted northern edge and a stretched eastern edge. These platforms fit together like pieces of a puzzle and tightly constrain the fit of Africa to South America. Our model predicts that in a Jurassic reconstruction, this volcanic edifice would

overlap the eastern third of the Bahamas Platform. This overlap is permissable if the overlapped portion of the Bahamas Platform is volcanic in origin and was created at the same volcanic center as the Demerara Plateau and the Guinea Plateau. Support for this hypothesis comes from the observation that the western Bahamas Platfrom is characterized as a broad, open carbonate shelf with many low relief islands whereas as the eastern Bahamas Platform is characterized by small islands (similar to seamounts) dissected by many deep channels. The difference in topography may reflect the dominantly volcanic nature of the eastern portion of the Bahamas. This break in seafloor topography is associated with steep gravity gradient, indicating a change in deep crustal structure.

Figure Captions:

1. 180.0 Ma (Middle Jurassic) - The Pangea reconstruction presented here is the starting point of this series. It is best reviewed by considering the constraints used to position each pair of continents:

a. South America - Africa: Demerara Plateau of northeastern Brazil and the Guinea Plateau of Mauritanian and Liberia fit together like keystones in an arch (J. Mascle et al, 1986). The eastern half of the Bahamas Platform is assumed to be a volcanic pile that formed at the same location during the initial phases of Jurassic rifting.
b. North America - Africa: Palinspastic restoration of the North American continental margin based on total tectonic subsidence model (Sawyer, 1985) is fit to the continental of northern Africa from the Pico Fracture Zone to the Blake Spur Fracture Zone.
c. Yucatan - North America: Volume of stretched crust in Gulf of Mexico is palinspastically restored using the total tectonic subsidence model of Dunbar and Sawyer (1986). Yucatan is rotated clockwise about 45 degrees from its present position to its fit position against the restored southern continental margin of North America.

d. South America - Bahamas Platform: Cuba is assumed to be underlain by a Jurassic to Maestrichtian age basement similar to that of the Bahamas Platform. This basement was overthrusted by Cenozoic forearc volcanic materials (volcaniclastics, ophiolites, turbidites) in the Paleocene. In the reconstruction, we have accounted for the area represented by the Bahamian-type basement of Cuba. Evaporites in Cuba have been tentatively identified as Callovian in age and are assumed to be equivalent to the Louann salt of the Gulf and the unnamed Jurassic salt south of Trinidad and Tabago.

All other tectonic elements were repositioned using the following criteria:

a. Terranes of northern South America (Romeral, Maricaibo, Santa Marta) - 100-150 km. of left-lateral offset is shown along the Bocono fault of northern South America. The offset is in response to the progressive west to northwest convergance of South America and the Caribbean plate.

b. Chortis block and the Nicaragua Rise (Honduras-El Salvador-Guatemala) - The restoration of these tectonic elements is based on the westward extension of 1000-1200 km. of strike-slip offset along the Cayman Trough. This reconstruction brings together similar Paleozoic metamorphic terranes in southwest Mexico, Guatemala and Honduras.

c. Yaqui and Guerrero Blocks (Mexico) - The Trans-Mexican volcanic belt is assumed to cover a large intra-continental shear zone similar to, and parallel to the Mojave-Sonora Megashear. Mexico probably cannot be modelled by simple rigid blocks and a more complex model that takes into account plastic deformation is required.

2. 160.0 Ma (Oxfordian, M 29) - Between 180-160 Ma the central Atlantic opened. This opening propagated into the Gulf of Mexico along a complex transform/strike-slip boundary along the ancestral Bahamas Fracture Zone and through central Florida into the Gulf of Mexico (Klitgord, Schouten, and Popenoe, 1984). Between 180 and 165 Ma, continental crust in the Gulf of Mexico was stretched and subsided. Near the end of this

phase, the Louann salt was deposited on the attenuated continental crust. Also during this time interval, approxiamately 500 km. of right-lateral offset took place along the Mojave-Sonora Megashear and the Trans-Mexican Volcanic Belt. The western half of the Florida Straits Block (containing the Bahama Platform with proto-Cuba) remained more or less fixed to Gondwana during this early phase of rifting. The eastern half of the Bahamas Platform was generated at a locus of excess volcanism in the vicinity of the Guinea Plateau and the Demerara Plateau. During this interval, Farallon oceanic crust was being continuously subducted along the western margins of North America, Chortis, and South America.

3. 143.8 Ma (Tithonian, M 19) - Between 165 and 150 Ma. oceanic crust was generated in the ancestral Gulf of Mexico (Buffler et al., 1983). This crust seperates the older salt basins and is comformably overlain by deep water clastics (Smackover equivalents). Throughout this interval, the Gulf of Mexico remained isolated from the Atlantic and was intermittantly connected through southwest Yucatan to the Pacific. At about 150 Ma., spreading stopped in the Gulf of Mexico and the spreading center jumped south between Yucatan and northern South America. This ridge generated the "Proto-Caribbean" seafloor crust which was later subducted by the advancing Caribbean plate. At the same time as the cessation of the Gulf of Mexico spreading, the fault north of the Bahamas Platform ceased motion and the Bahamas Platform became part of the North American plate. The southern edge of the Bahamas Platform was a transform fault margin, and the northern South American and southern Yucatan margins were passive rift margins. Subduction was continuous in an east-facing arc that extended from southern Chortis block to northwestern South America.

4. 118.7 Ma (early Aptian, M 0) - Cretaceous seafloor spreading was well underway forming the "Proto-Caribbean". Passive margins extended from northeastern Brazil to

northwestern Colombia and from southern Chortis to northeastern Yucatan. Subduction of the Farallon plate continued along an east facing inter-oceanic arc between the western margins of North America and South America. The arc increased in length with time, accommodating the widening gap between North and South America.

5. 100.0 Ma (late Albian, KQZ) - Seafloor spreading continued to produce crust between North and South America. The separation between North and South America reached a maximum about this time. At about 100 Ma, the polarity of subduction beneath the volcanic arc between North and South America changed from an east-dipping to a west-dipping polarity. The reason for the change of subduction polarity is not known, but it is probably due to the change in plate geometry resulting from the widening gap between North and South America. Basalts below the B" seismic layer found by DSDP Leg 15 were also intruded at this time, thickening the crust and possibly making it more difficult to subduct (Burke et al., 1978). The change in polarity caused the relative motion between North America, South America and the Farallon plate to change so that the Farallon plate begin to intrude between North and South America. Later in the Cretaceous, when subduction begins on the southwestern edge (trailing edge) of this plate, it will break it from the Farallon plate and the isolated oceanic plate will then become the Caribbean plate.

6. 84.0 Ma (mid-Campanian, KQZ) - Seafloor spreading in the "Proto-Caribbean" had stopped by this time, implying that the separation of North and South America had ceased. The Farallon plate, carrying the Greater Antilles arc on its leading edge, continued to consume the "Proto-Caribbean" plate as it moved northeastward. Portions of the Nicaragua Rise (as well as Jamaica) were on the leading edge of the arc. The southern edge of the Chortis block acted as a transform margin carrying the Farallon plate northeastward, but the position of the Chortis block relative to Mexico did not change.

7. 72.0 Ma (late Campanian, AN 32) - By this time, slow subduction of the "Proto-Caribbean" plate and/or inter-plate stresses caused the Caribbean plate to seperate from the Farallon plate. The new Caribbean plate was bounded by the Greater Antilles arc to the northeast, a transform margin to the northwest, a transform margin to the southeast, and a east-dipping subduction margin to the southwest. The northwestward-dipping subduction on the trailing edge of the Caribbean plate created the Panama arc. Continued northeastward movement of the Caribbean plate was hindered when the northwestern corner of the Caribbean plate encountered the Yucatan salient at about this time. The southern margin of Yucatan was shortened as a part of the Greater Antilles arc obliquely collided with it, obducting the Santa Cruz and associated ophiolites and producing the Sepur foredeep. Part of the Nicaragua Rise was left behind (as was Jamaica) and most of the Caribbean plate continued northeastward along the Hess Escarpment. In northern South America, the oceanic terranes of western Colombia were obducted as the Caribbean plate began to be subducted beneath northern South America. A complicated trench-to-trench transform developed and lengthened, as "Proto-Caribbean" crust was subducted beneath the Greater Antilles arc to the north and west, and Caribbean plate crust was subducted beneath northern South America to the south and east.

8. 59.2 Ma (Late Paleocene, AN 25) - The collision of the Greater Antilles arc with the southern edge of the Bahamas platform caused the Caribbean plate motion to change from northeastward to eastward at during the Late Paleocene. The Yucatan basin at the front of the Greater Antilles arc opened as an inter-arc basin, spreading in a northwest-southeast direction. This resulted in the obduction of ophiolites and volcaniclastics over the passive Bahamas Platform margin and formation of Cuba. The change in plate motion caused the northeast-southwest North America- Caribbean plate boundary to jump from the Hess escarpment to the dominantly east-west Polochic-Motagua-Jocotan megashear. This change in plate boundary captured the Chortis block and associated terranes and accreted

them to the Caribbean plate. Strike-slip motion along the Hess Escarpment had finished by this time. In the Late Paleocene, subduction to the west of Chortis was continuous with subduction to the west of the Caribbean plate (Panama). Subduction of the "Proto-Caribbean"/Atlantic crust continued on the eastern edge of the Caribbean plate producing the Aves Ridge arc, as did the subduction of Caribbean plate in northern South America.

9. 50.3 Ma (Middle Eocene, AN 21) - During the Middle Eocene through the early middle Tertiary, eastward motion of the Caribbean plate relative to North America continued, and tectonic activity along the Cayman Ridge/Yucatan Basin/Cuba corner of Caribbean ceased. The Caribbean plate (including Chortis) carried part of the Greater Antilles arc away from the Cayman Ridge along east-west strike-slip faults. These areas were destined to become Hispaniola/Puerto Rico. A slight bend to the north of the predominantly east-west northern strike-slip boundary of the Caribbean plate caused the initiation of a left-stepping, left-lateral pull-apart basin. This basin later became the Cayman Trough, but during this time interval, crust was being extended without the injection of oceanic basalts. Westward subduction of Atlantic crust beneath the Caribbean plate with associated volcanism at the Aves Ridge arc continued, as well as eastward subduction of the Caribbean plate beneath Colombia and eastward subduction of the Farallon plate beneath the trailing edge of the Caribbean plate along the Panama arc.

10. 44.1 Ma (Late Eocene, AN 19) - During the Middle Tertiary, eastward motion of the Caribbean plate relative to North America continued, with left lateral motion between Chortis (on the Caribbean plate) and Guerrero/Yucatan (on the North American plate). Relative motion took place along the Motagua-Polochic-Jocotan megashear into a left-stepping pull-apart basin (the proto-Cayman Trough) and along the southern edge of the Cayman Ridge. Initiation of the intrusion of basaltic crust in the Cayman Trough occured at about this time. A series of left-lateral faults splayed through the Greater Antilles arc,

shortening it through time. This shortened portion of the the arc will become Hispaniola. Most of the motion between Hispaniola take place along the northern fault (The Oriente), which connected with the subduction along the front of the Caribbean plate at the Lesser Antilles arc. In northern South America, right-lateral motion occured offshore along a tranform fault between the west dipping Lesser Antilles arc and the east dipping arc in northwest Columbia. Another right-lateral transform fault carried the Caribbean plate - South American plate motion south of southernmost Panama. Arc volcanism continues in Panama-Costa Rica as east-dipping subduction consumes Farallon crust beneath the trailing edge of the Caribbean. On the Caribbean plate, non-rigid stretching extended the northern Nicaragua Rise in an northeast-southwest direction as the Chortis block came around the Yucatan salient.

11. 35.9 Ma (Early Oligocene, AN 13) - Relative motions of the plates in the circum-Caribbean region are the same as during the Late Eocene (AN 19, 44.1 Ma.) except:

a) Shortening of Greater Antilles arc into Hispaniola along splays of the Oriente fault had ceased.

b) Puerto Rico basin (between central Hispaniola and Puerto Rico) opened as a result of relative motion between Hispaniola and the Caribbean plate. This same motion carried the Southern Hispaniola Peninsula (on the Caribbean plate) to the east along the Enriquillo-Plantain Garden fault zone.

c) During this time interval, the eastern edge of the Nicaraguan shelf (between Hess escarpment and Pedro Bank/Rosalind Bank) stretched east-west as relative motion between Chortis and Caribbean plate took place (Bowland, 1984). The Nicarauga Rise was also stretching during this interval as the left-lateral strike-slip faults of the Cayman Trough-Polochic-Motagua-Jocotan megashear brought the Nicarauga Rise around the Yucatan Salient.

12. 20.5 Ma (Early Miocene, AN 6) - Relative motions during this interval are the same as during the Early Oligocene (AN 13, 35.9 Ma) except:

a) progressive suturing from south to north of Panama onto western Columbia.

b) Gulf of California had begun to open as Baja Mexico has begun to slide northward.

c) As the Chortis block moved eastward during this period, the Chiapas Massif became exposed to north-northeast compressional stresses. In response, it began to rotate clockwise, folding and overthrusting the basin behind it, forming the southern Mexican foldbelt.

13. 10.6 Ma (Late Miocene, AN 5) -Relative motions during this interval are the same as during the Early Miocene (AN 6, 20.5 Ma) except:

a) rotation of Chiapas Massif has ceased.

b) the Grenada basin opened as a back-arc basin and the axis of subduction-related volcanism moved east from the Aves ridge to the Lesser Antilles arc.

14. 0.0 Ma (Present, AN 1) - "Neotectonics" - At present, the Caribbean plate continues to move eastward relative to North and South America at less than 2 cm. per year, while north-south convergance of North and South America overprints and complicates the dominantly strike-slip movements. Motion of Puerto Rico relative to central Hispaniola has ceased, and all motion between North America and the Caribbean plate occurs along the Oriente fault and the Puerto Rico Trench. Southern Panama has sutured to western Columbia.

References cited:

Bowland, C.L., Seismic stratigraphy and structure of the western Columbian basin, Caribbean sea, Unpublished Ms. Thesis, Univ. of Texas at Austin, Dept. of Geol. Sci., 1984.

Buffler, R.T., J.S. Watkins, F.J. Shaub, and J.L. Worzel, Structure and Early Geologic History of the Deep Central Gulf of Mexico basin, in The Origin of the Gulf of Mexico and the Early Opening of the Central North Atlantic Ocean, edited by R.H. Pilger, P. 3-16, Baton Rouge, La. 1980.

Burke, K., P.J. Fox, and A.M.C. Sengor, Bouyant ocean floor and the evolution of the Caribbean, J. Geophys. Res., 1978.

Dunbar, J., and D. Sawyer, Crust Extension within the Gulf of Mexico, Implications for the Breakup of Western Pangea, Texas A&M Geodynamics Symposium (abs.) 1986.

Klitgord, K.D., and H. Schouten, Plate Kinematics of the Central Atlantic, Chap. 22 in The Geology of North America, The Western North Atlantic Region, P.R. Vogt and B.E. Tucholke, eds., Geo. Soc. Amer. DNAG Series,Vol M., in press.

Klitgord, K.D., J. Schouten, and P. Popenoe, Florida: A Jurassic transform boundary, J. Geophys. Res., 1984.

Mascle, J. M. Marinho, and J. Wannesson, The structure of the Guinean continental margin: implications for the connection between the central and southern Atlantic Oceans, Geologische Rundschau, 1986.

Pindell J., and S.F. Barrett, Geological Evolution of the Caribbean Region: a Plate Tectonic Perspective, Geo. Soc. Amer. DNAG Series, Vol H, in press.

Rosencrantz, E., Ross, M.I. and J.G. Sclater, The age of the Cayman Trough, Caribbean Sea: Evidence from magnetic anomalies, in prep., 1987.

Rosencrantz, E., and J.G. Sclater, Depth and Age in the Cayman Trough, Earth and Plan. Sci. Letters, 1986.

Sawyer, D., Total Tectonic Subsidence: A parameter for distinguishing crust type at the U.S. Atlantic contniental margin, J. Geophys. Res., 1985.

180 Ma (Middle Jurassic)

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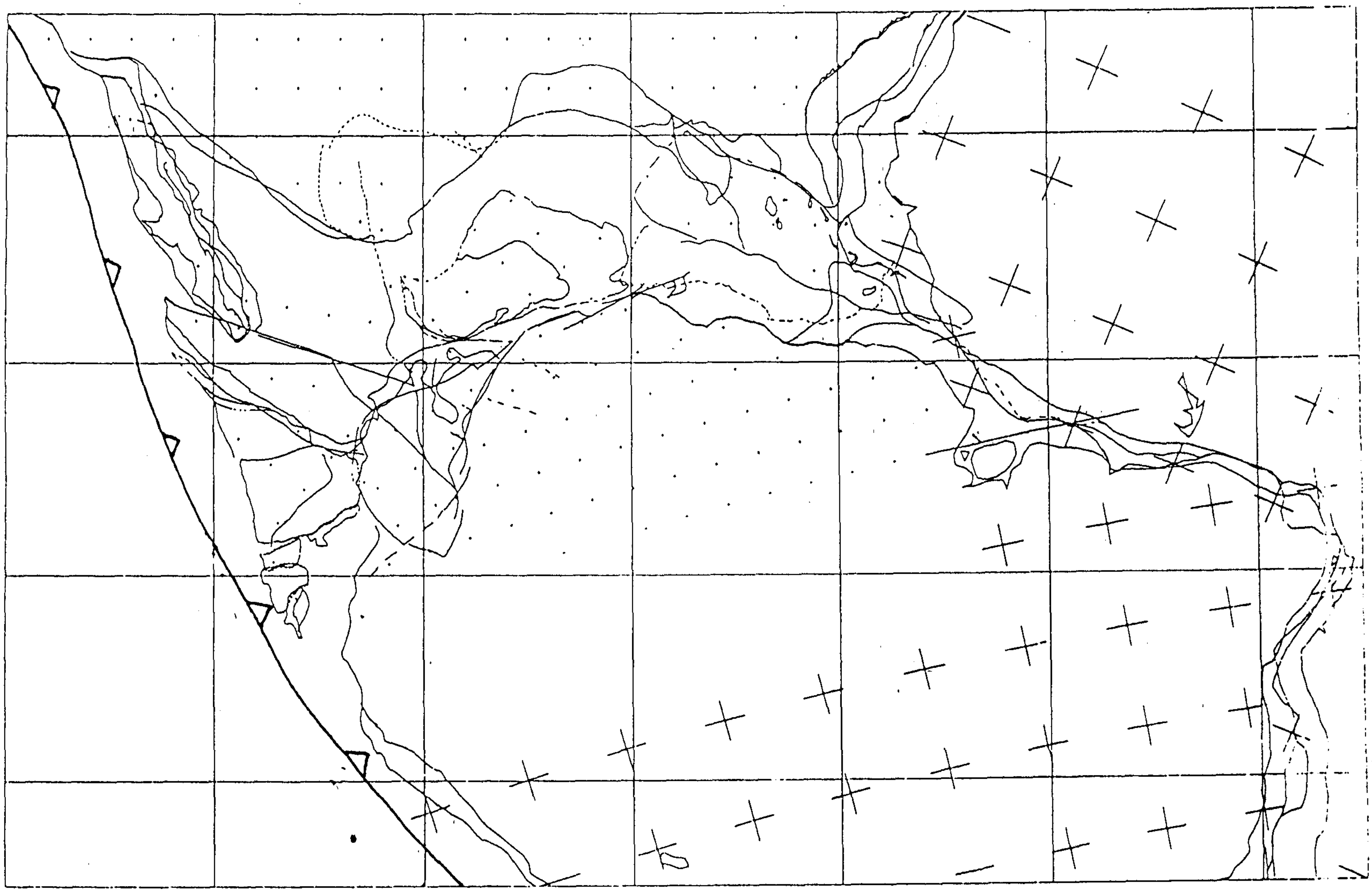

160.0 Ma (Oxfordian, M29)
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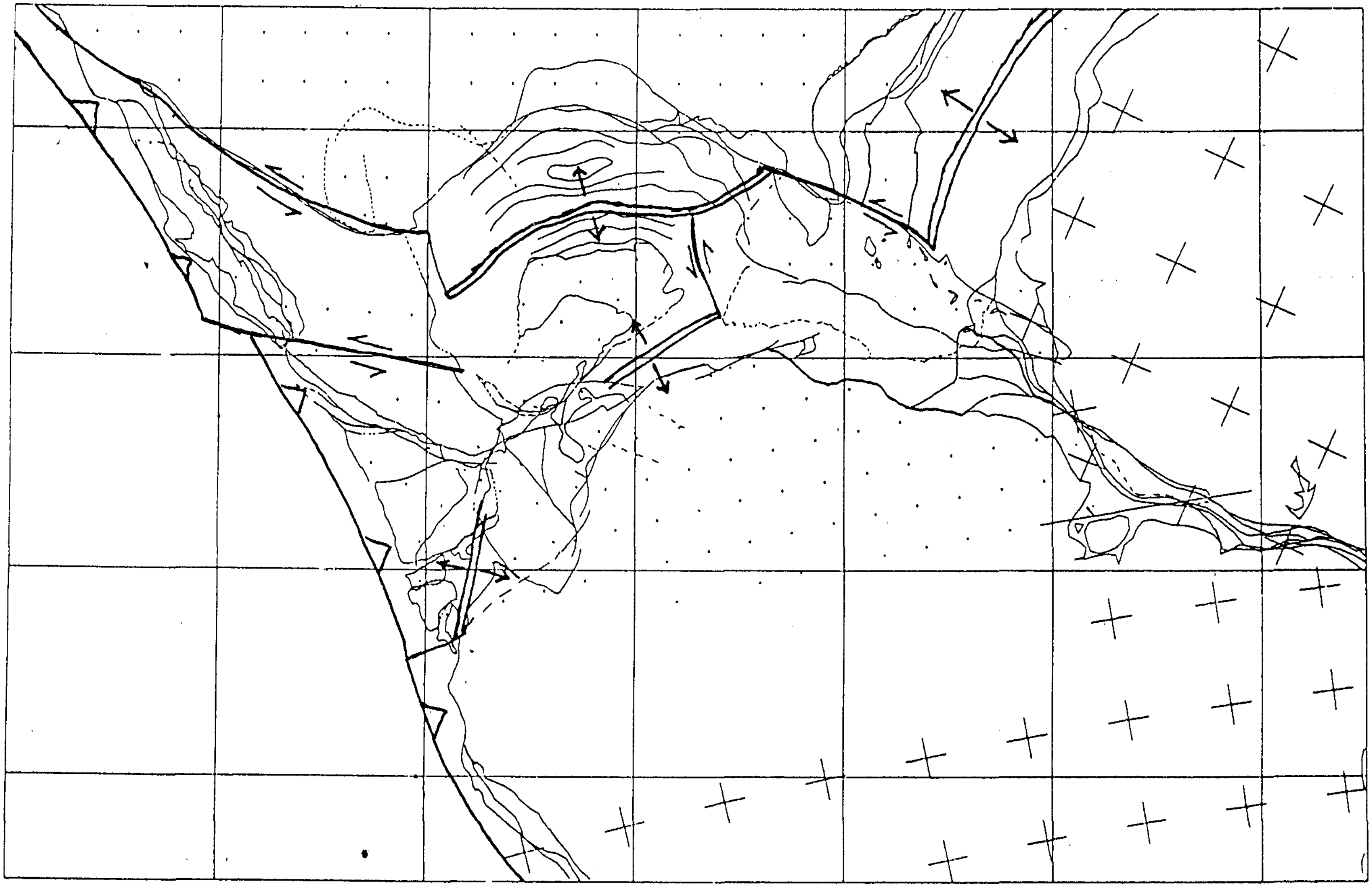

143.8 Ma (Tithonian, M 19)

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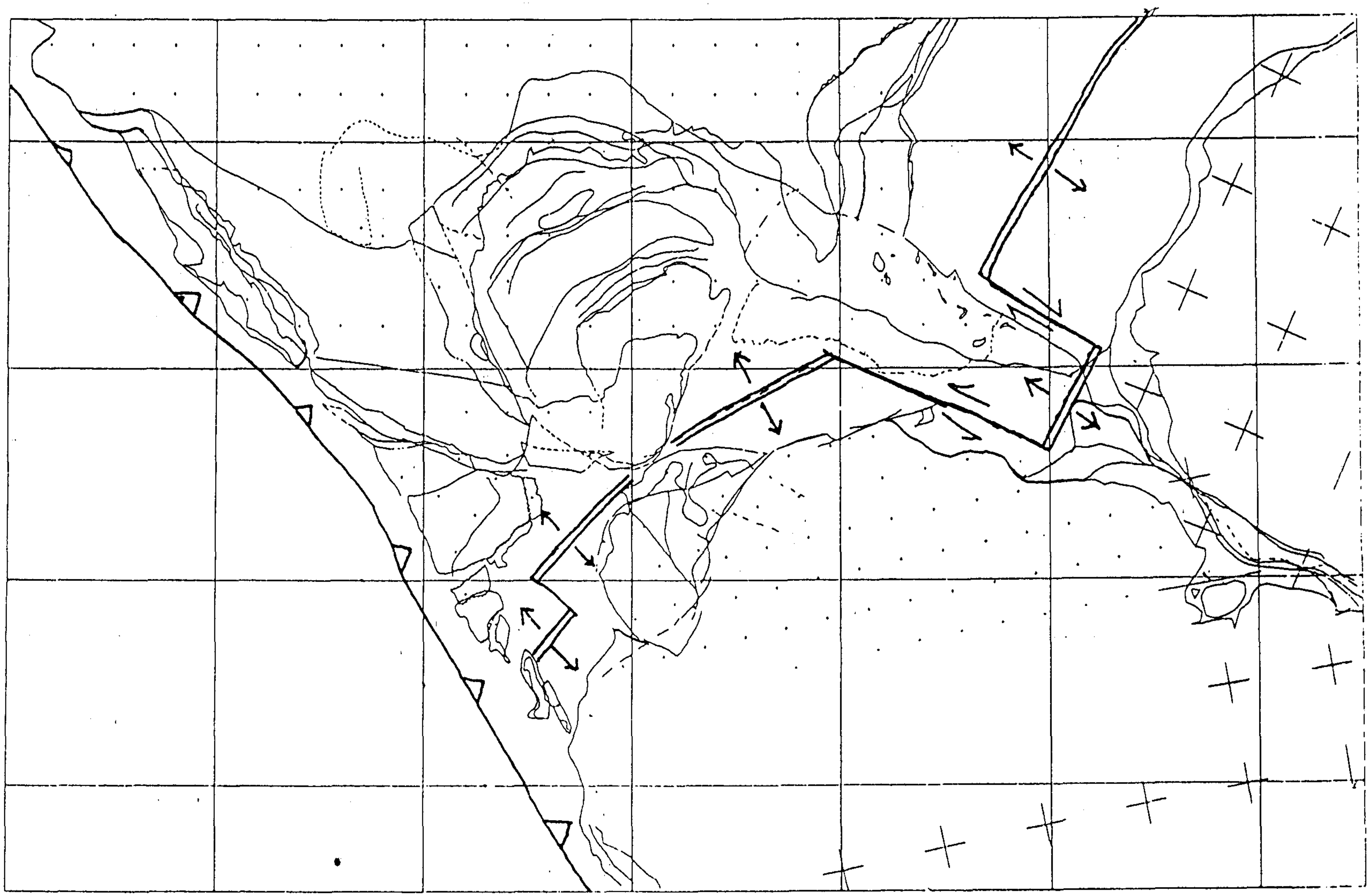

118.7 Ma (early Aptian, M 0)

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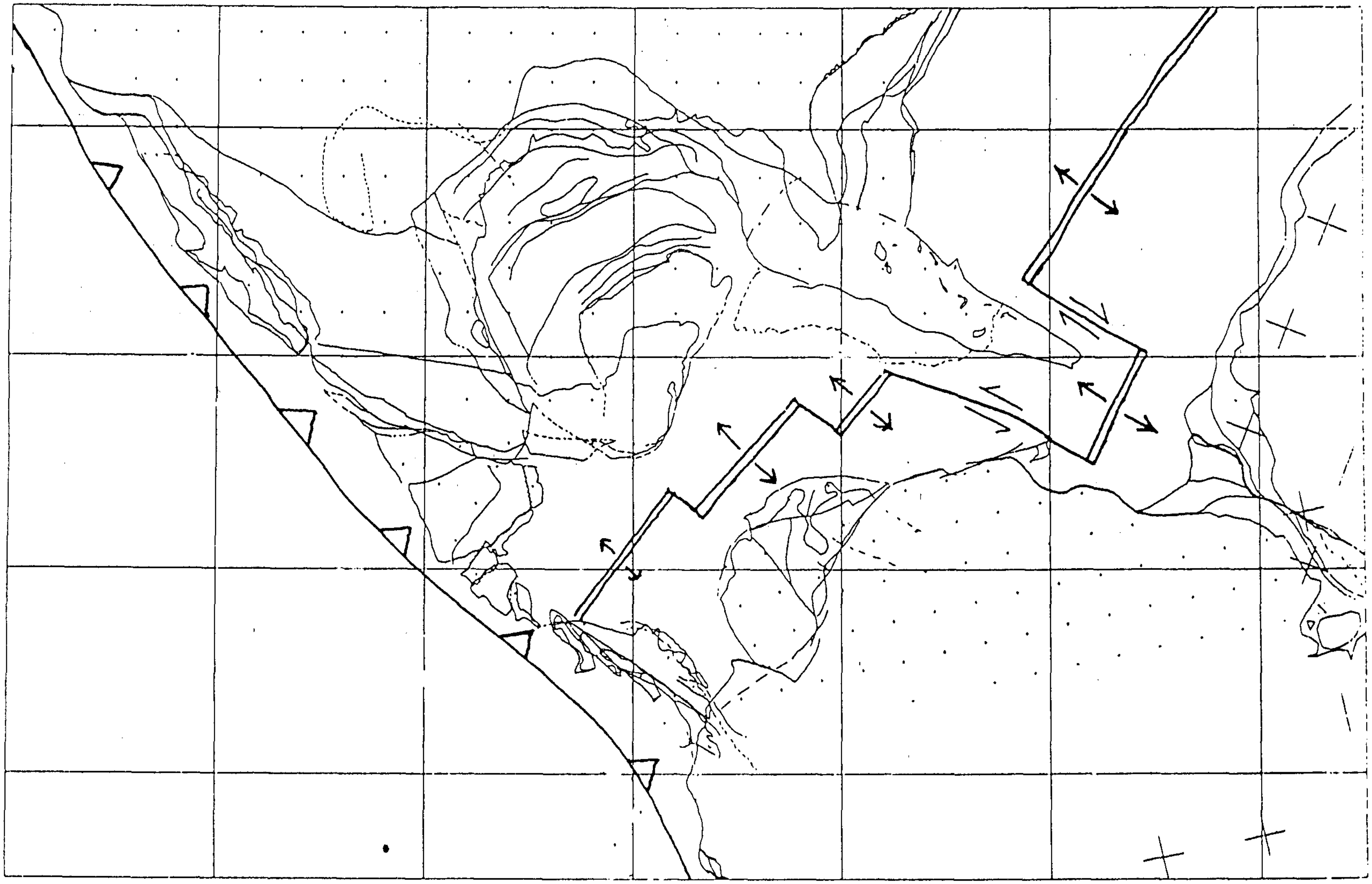

100.0 Ma (late Albian, KQZ)
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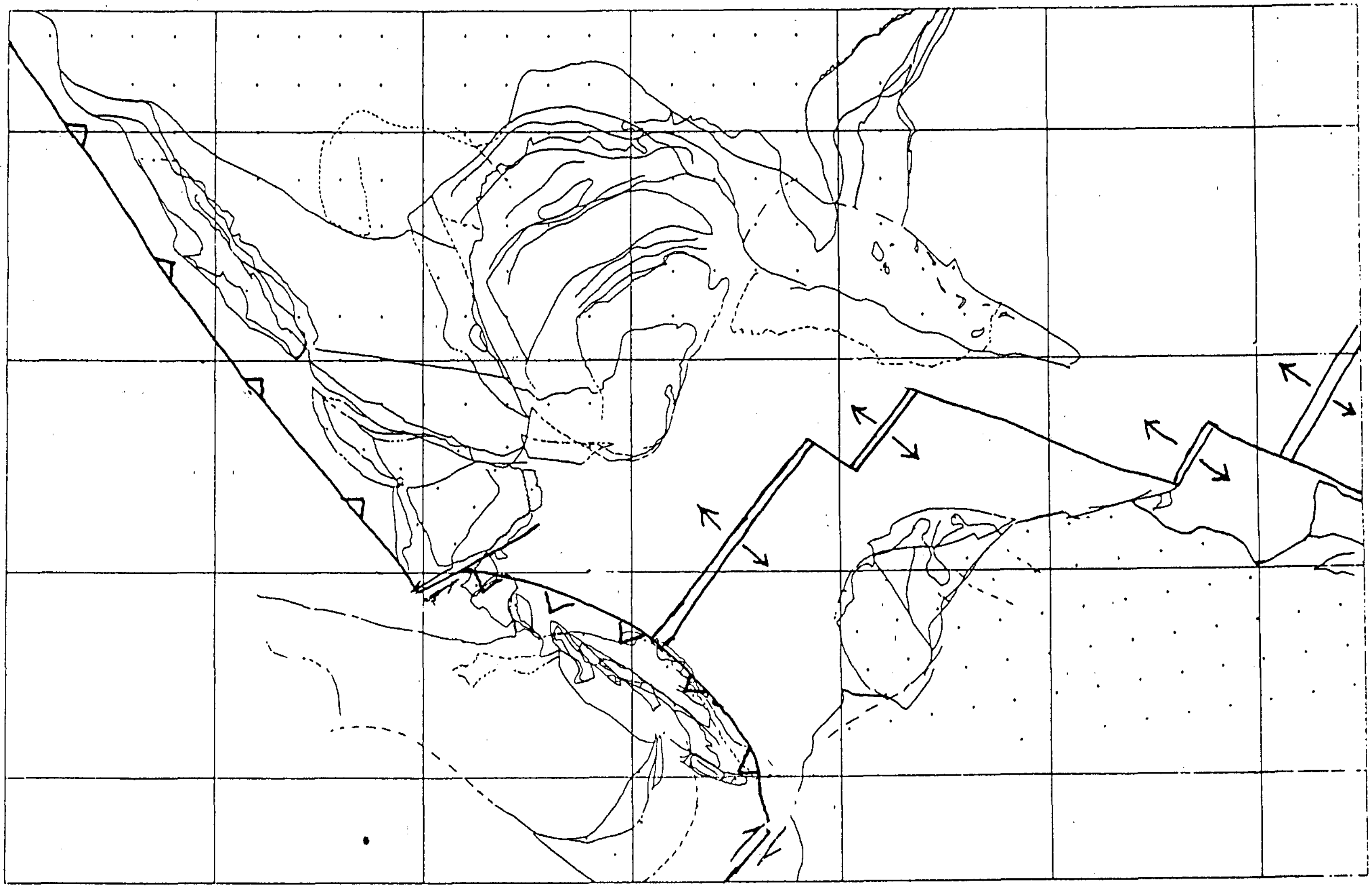

84.0 Ma (mid-Campanian, KQZ)

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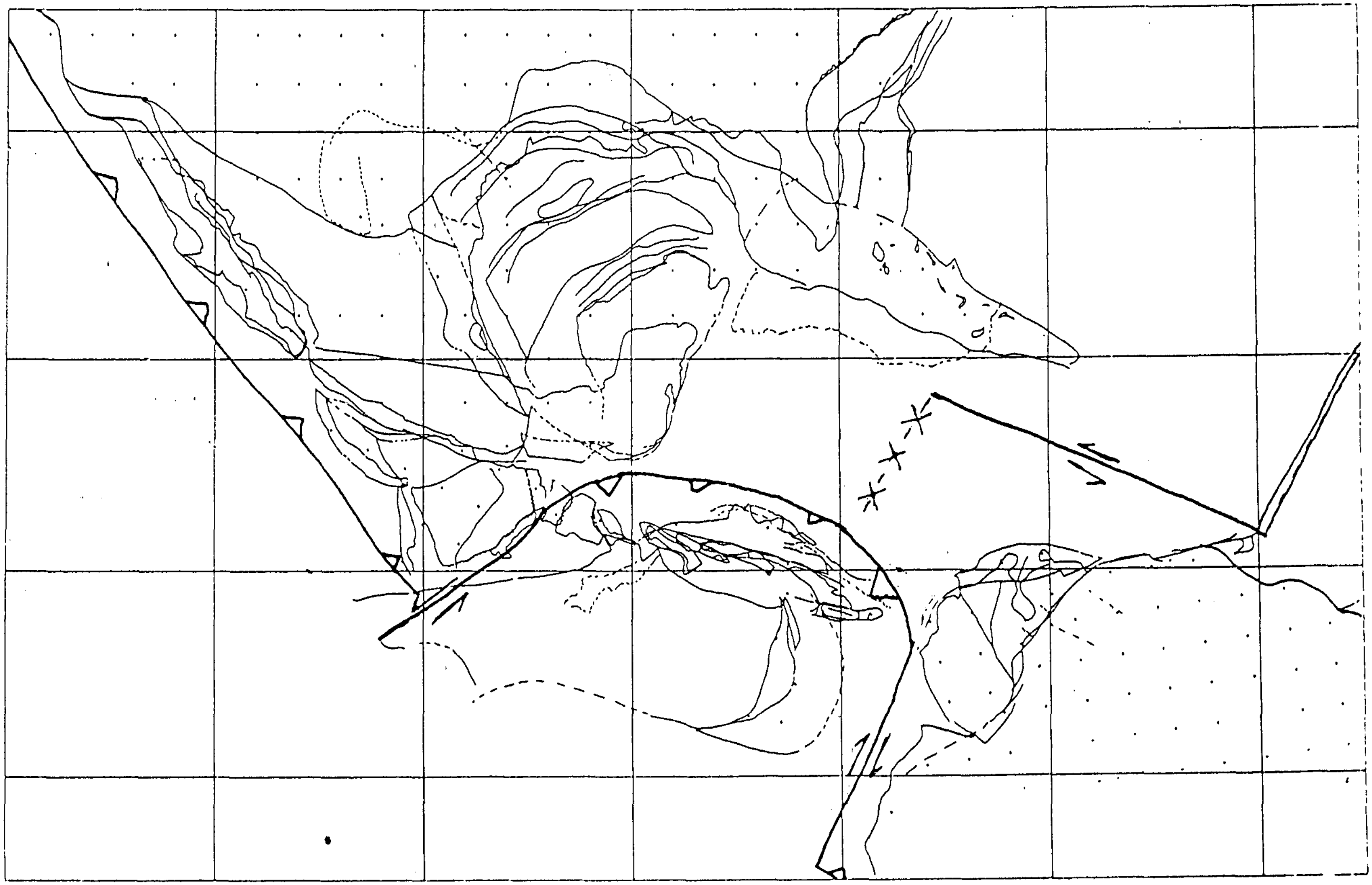

72.0 Ma (late Campanian, AN 32)
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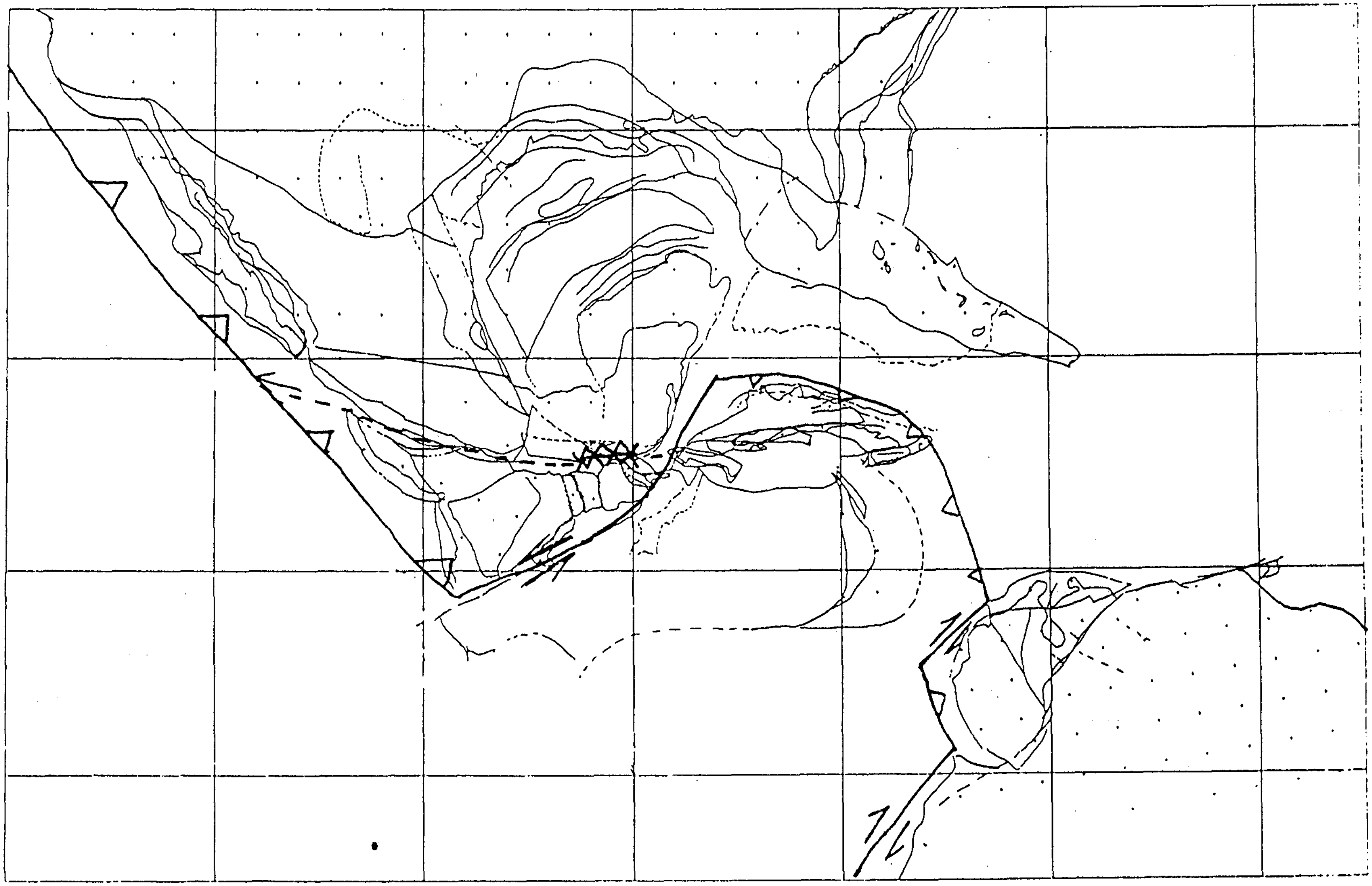

59.2 Ma (Late Paleocene, AN 25)

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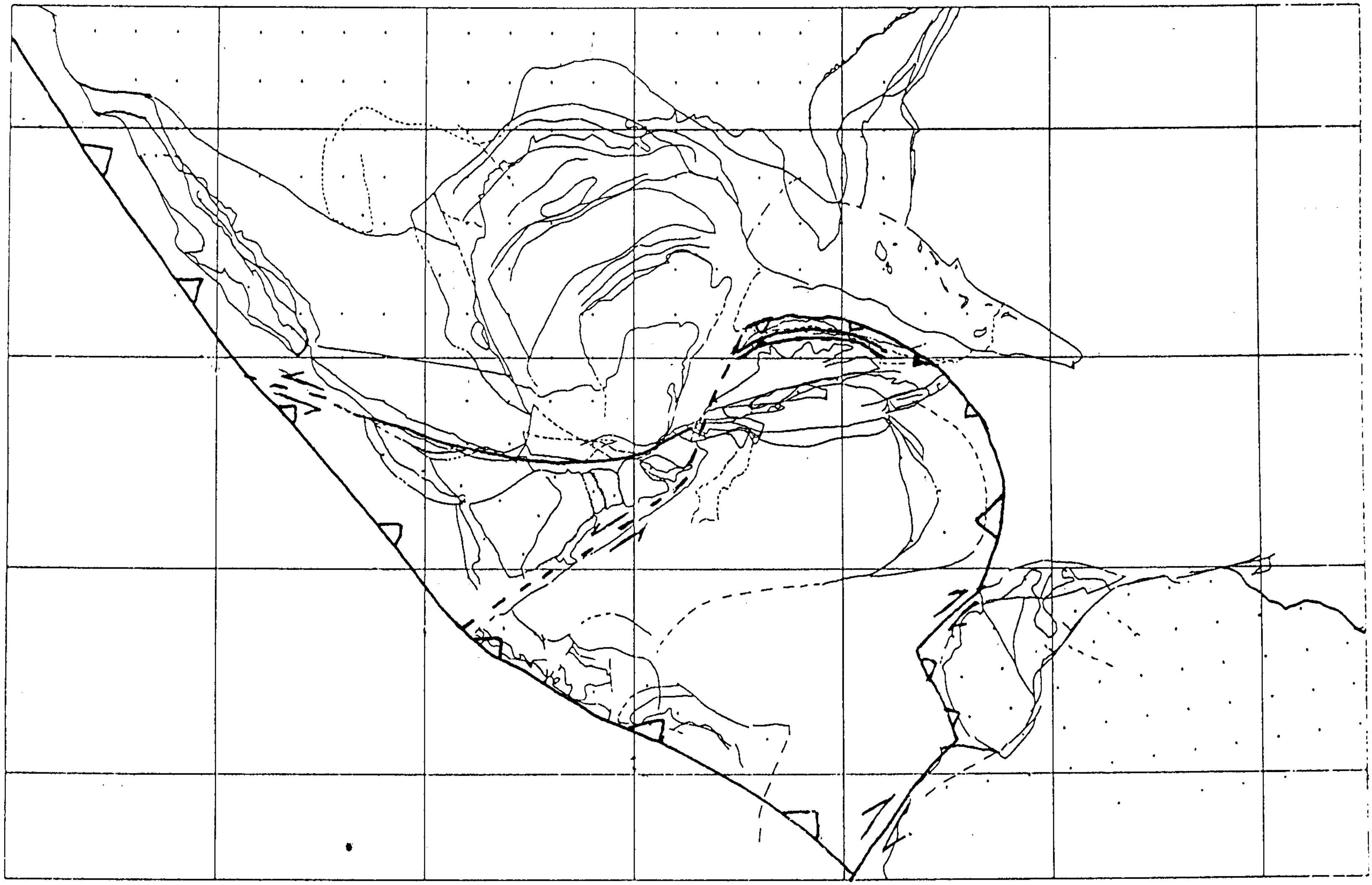

50.3 Ma (Middle Eocene, AN 21)
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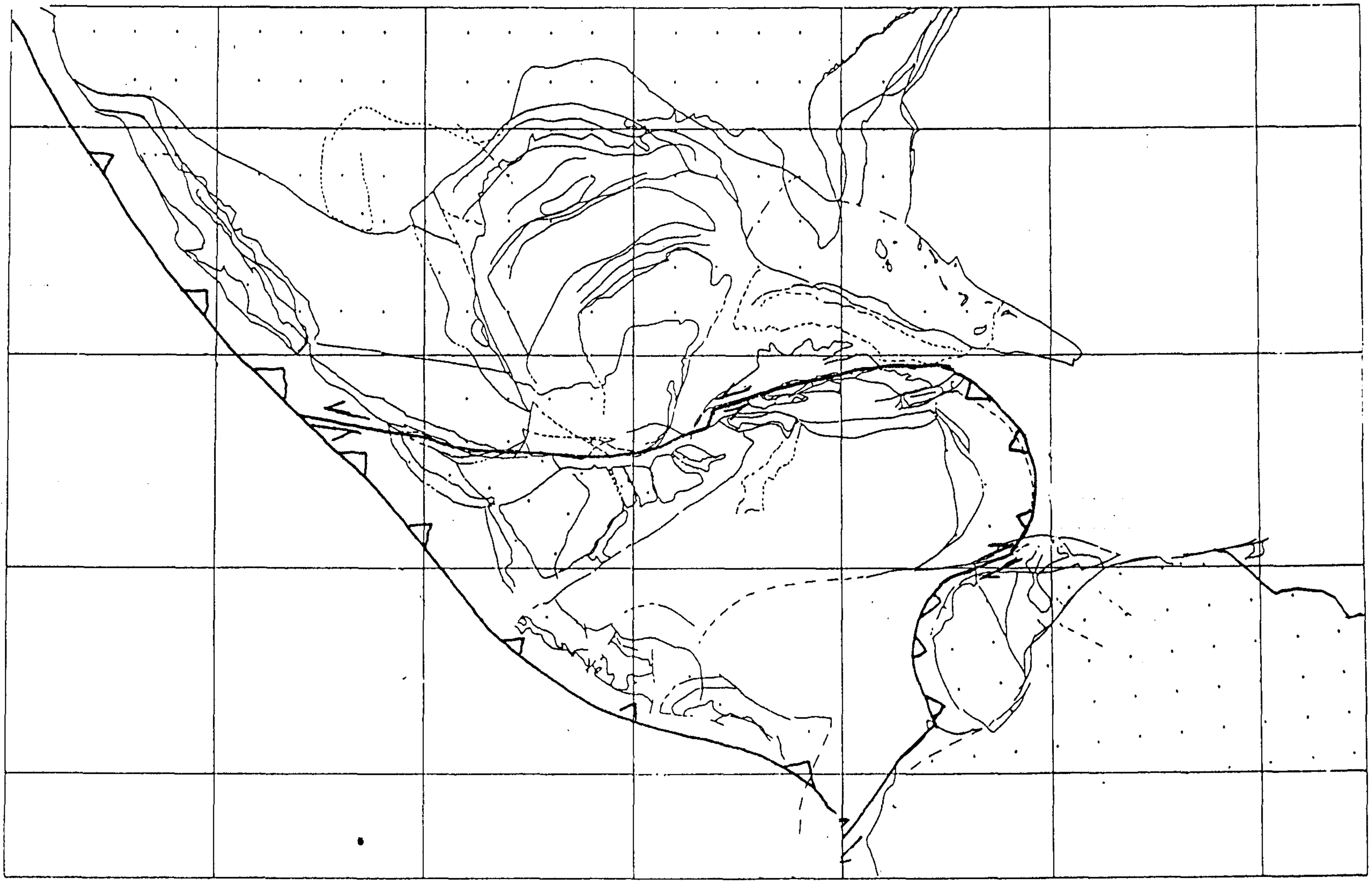

44.1 Ma (Late Eocene, AN 19)

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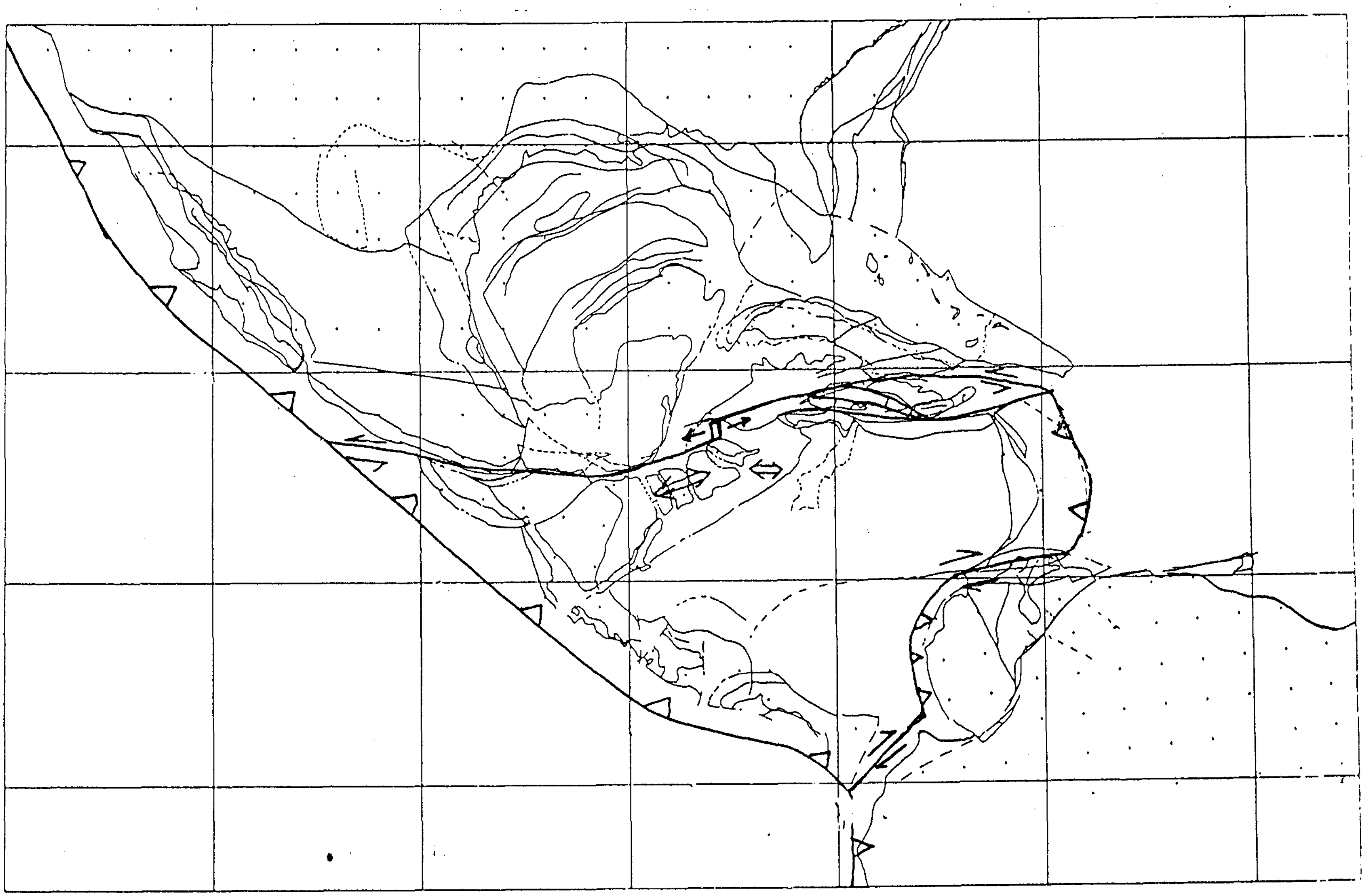

35.9 Ma (Early Oligocene, AN 13)

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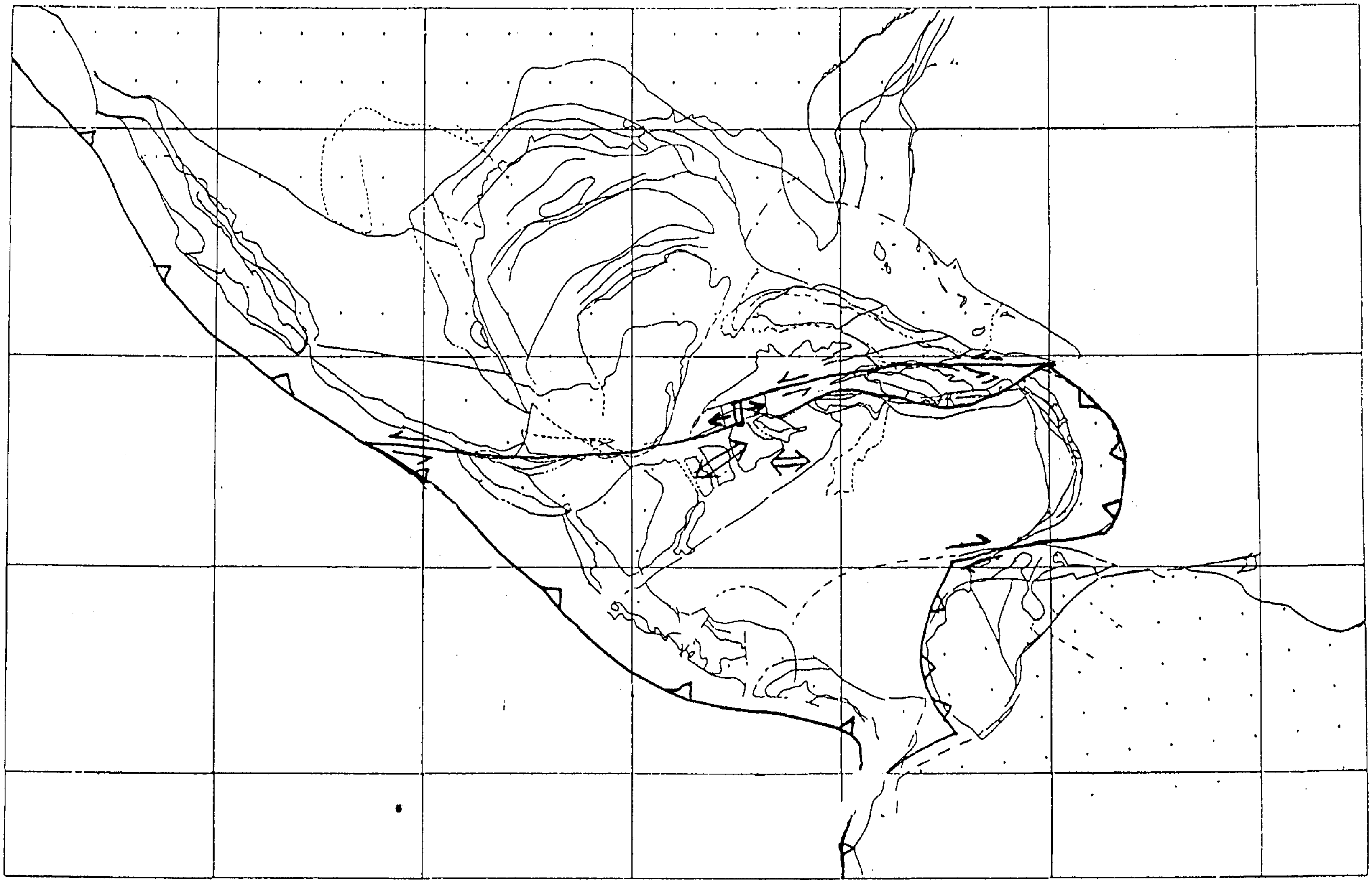

20.5 Ma (Early Miocene, AN 6)

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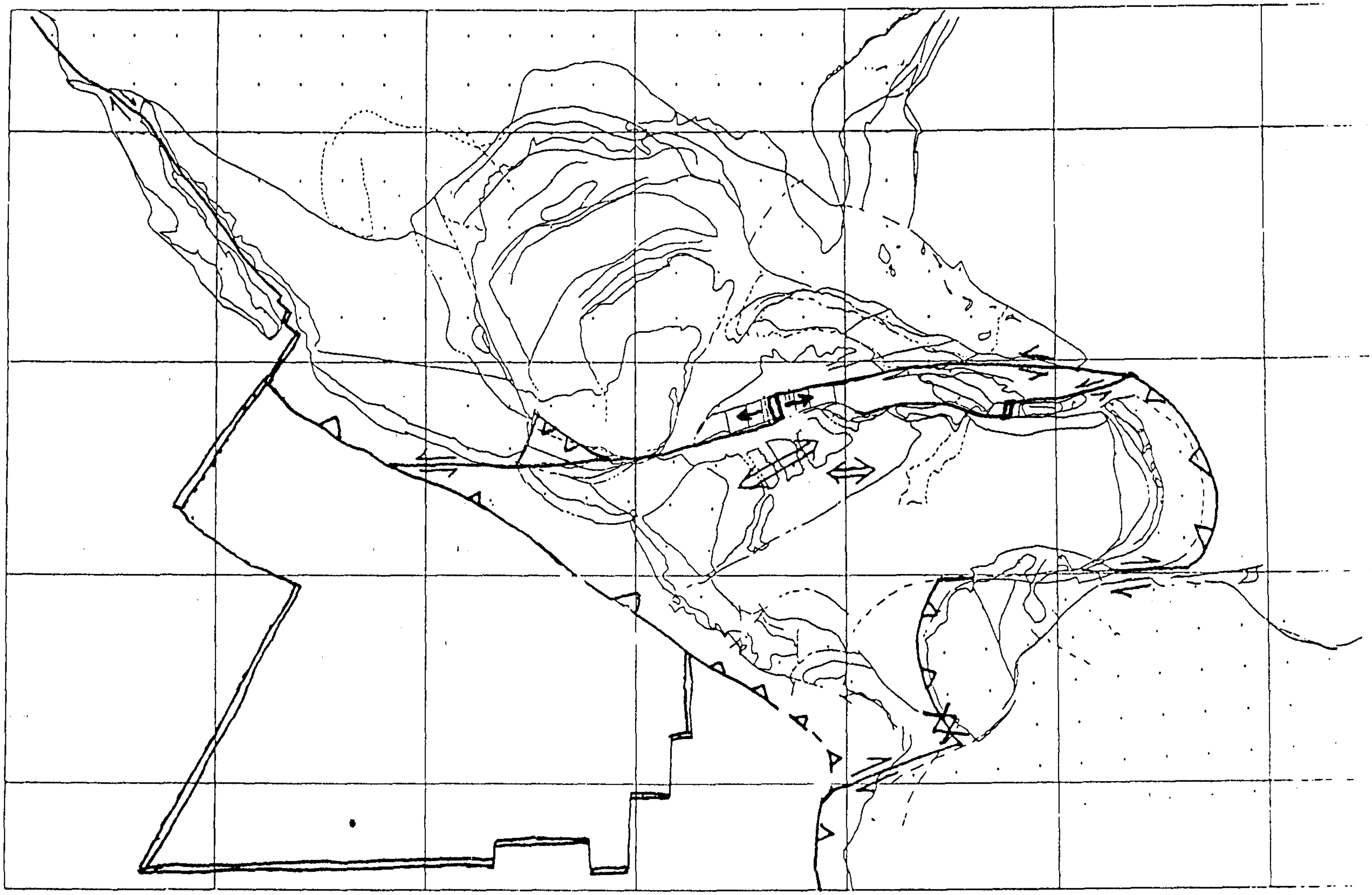

10.6 Ma (Late Miocene, AN 5)
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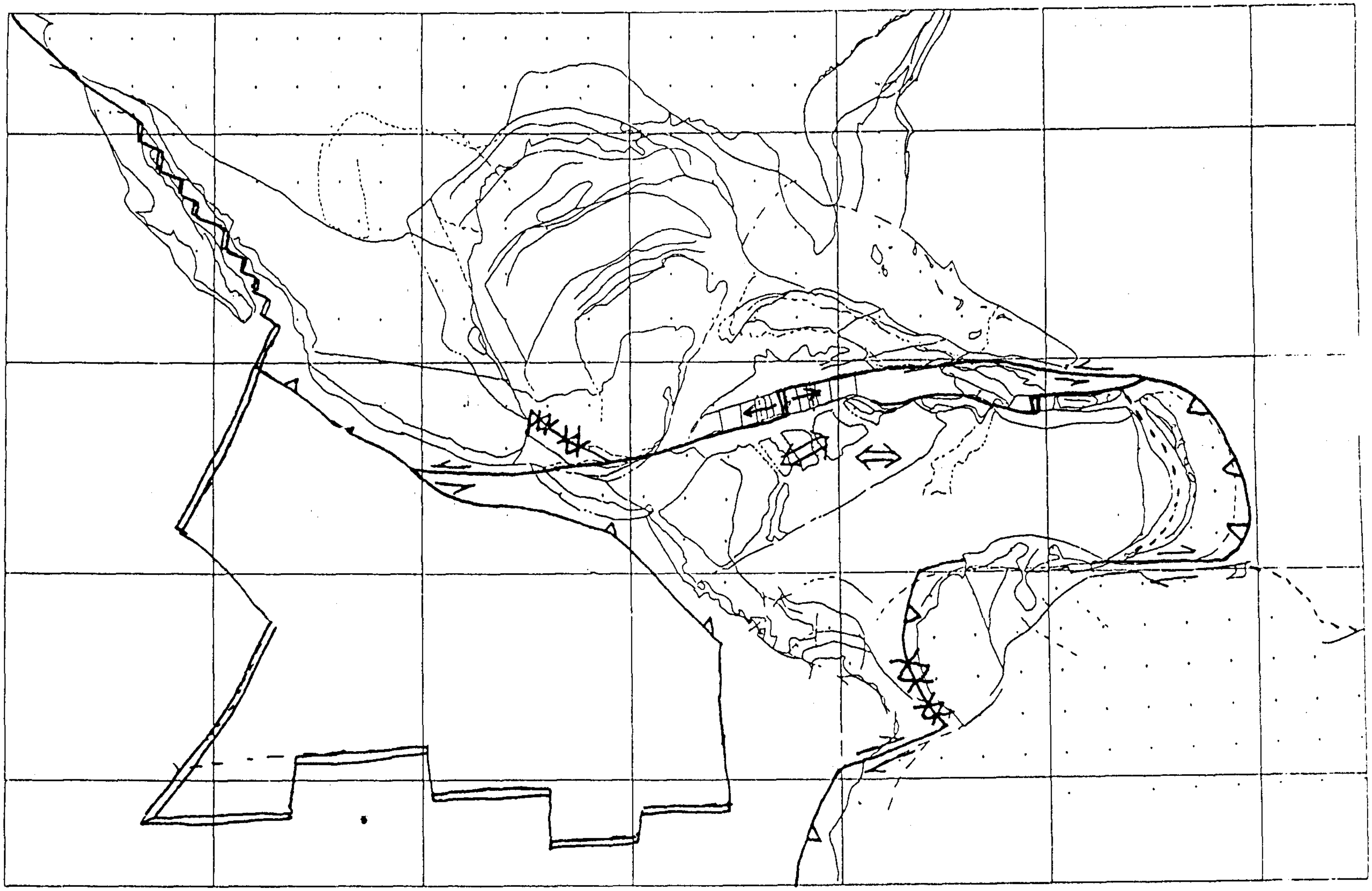

0.0 Ma (Present)

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