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INCLINOMETER STRAIN ANALYSES OF ANCHORAGE LANDSLIDES, 1965-80

By
Randall G. Updike

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Supported under a Cooperative Research Project with the Office of Earthquake Studies, Earthquake Hazards Reduction Program, U.S. Geological Survey

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STATE OF ALASKA

Bill Sheffield — *Governor*

Esther Wunnicke — *Commissioner*

Ross G. Schaff — *State Geologist*

Cover photo: Grabenlike soil failure destroyed the Anchorage Government Hill School, March 27, 1964. (Photo--B77.118.121--courtesy Anchorage Historical and Fine Arts Museum; U.S. Army Corps of Engineers photo negative 398.)

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CONTENTS

FIGURES

TABLES

INCLINOMETER STRAIN ANALYSES OF ANCHORAGE LANDSLIDES, 1965-80

By Randall G. Updike[1]

ABSTRACT

Several large destructive landslides occurred in Anchorage, Alaska when sensitive and liquefiable facies within the Bootlegger Cove Formation failed during the 1964 Prince William Sound Earthquake.

Twenty-five slope-inclinometer casings were installed in and around the three largest landslides immediately after the earthquake, and four additional casings were installed in 1977 and 1978.

Fourteen of the 29 casings were relocated and resurveyed in 1979. A comparison of new data with previous records and with detailed engineering geologic stratigraphy indicates that negligible strain has occurred in the vicinity of the Turnagain Heights and L Street slides; however, in the 'buttress area' of the Fourth Avenue slide, several zones of up to 3 in. deflection occurred prior to 1977.

Although potentially unstable soils remain, no significant strain has occurred in these three major slide areas.

INTRODUCTION

From its beginnings as a construction camp for the Alaska Railroad just prior to World War I, Anchorage (then Ship Creek) has grown markedly, despite the presence of natural phenomena such as volcanic eruptions, floods, high winds, and avalanches.

The occurrence of one of these hazards, the Prince William Sound Earthquake of March 27, 1964---also known as the Good Friday Earthquake---remains Anchorage's most renowned catastrophic event. The earthquake was manifested by a variety of effects, including massive ground failure at several locations at or near bluffs in the city.

I am studying the soil strength and mobility potential of these slide zones to determine the likelihood of future failure of the same or adjacent soils masses, both with and without another major earthquake.

GEOLOGIC SETTING

Anchorage is situated on a broad alluvial plain that slopes gently from the Chugach Mountains on the east to Cook Inlet on the west and south (fig. 1). The plain is truncated by bluffs up to 130 ft high along both Cook Inlet and major streams flowing to the inlet from the mountains. The bluffs expose a complex of unconsolidated sediments that are often at or near saturation. These free faces, coupled with certain subsurface geologic conditions, contribute to the inherent instability of the land adjacent to the bluffs. This is compounded by the geologic setting: Anchorage is located within an active tectonic framework (fig. 1). Earthquakes are frequently felt. There are active fault traces in nearby Quaternary deposits.

Anchorage is situated on the eastern margin of the Cook Inlet forearc basin. This tectonic basin is bounded on the northwest by the Bruin Bay-Castle Mountain fault system and on the southeast by the Border Ranges fault system (fig. 1). Seismicity occurs along both fault systems and along the underlying Benioff zone, which is caused by subduction of the Pacific plate beneath Alaska.

Although most seismic events occur along this zone of underthrusting (Stephens and others, 1980), the likelihood of near-surface events associated with the fault system is significant. Seismic events related to the Castle Mountain system are generally of low magnitude (M = 3.0 to 4.5) and shallow, even though the potential for larger magnitudes (>6.0) is quite real (John Lahr, pers. commun., 1980).

The Border Ranges fault system is more of an enigma. No evidence has been found to document that fault traces truncated late Quaternary deposits along the Chugach Mountains east to northeast of Anchorage. Unpublished work of other investigators provide evidence for low-magnitude Holocene seismicity along the Border Ranges fault, but source of the seismicity remains questionable.

Bedrock in the Anchorage area consists of Tertiary clastic sedimentary rocks and older metamorphic rocks of the Chugach Mountains, and is generally 325 to 650 ft below the surface. Engineering and design criteria are focused on the thick unconsolidated sedimentary sequence that was deposited predominantly in Pleistocene time and partially reworked during Holocene time. The best summaries of the Quaternary geologic history are those of Miller and Dobrovolny (1959), Karlstrom (1964), and Schmoll and Dobrovolny (1972).

Upper Cook Inlet has had a varied Quaternary history. The geologic record---produced by the interplay of fluctuations in sea level, advances and retreats of adjacent mountain glaciers, and tectonic subsidence and uplift---is indeed complex, and details of this history,

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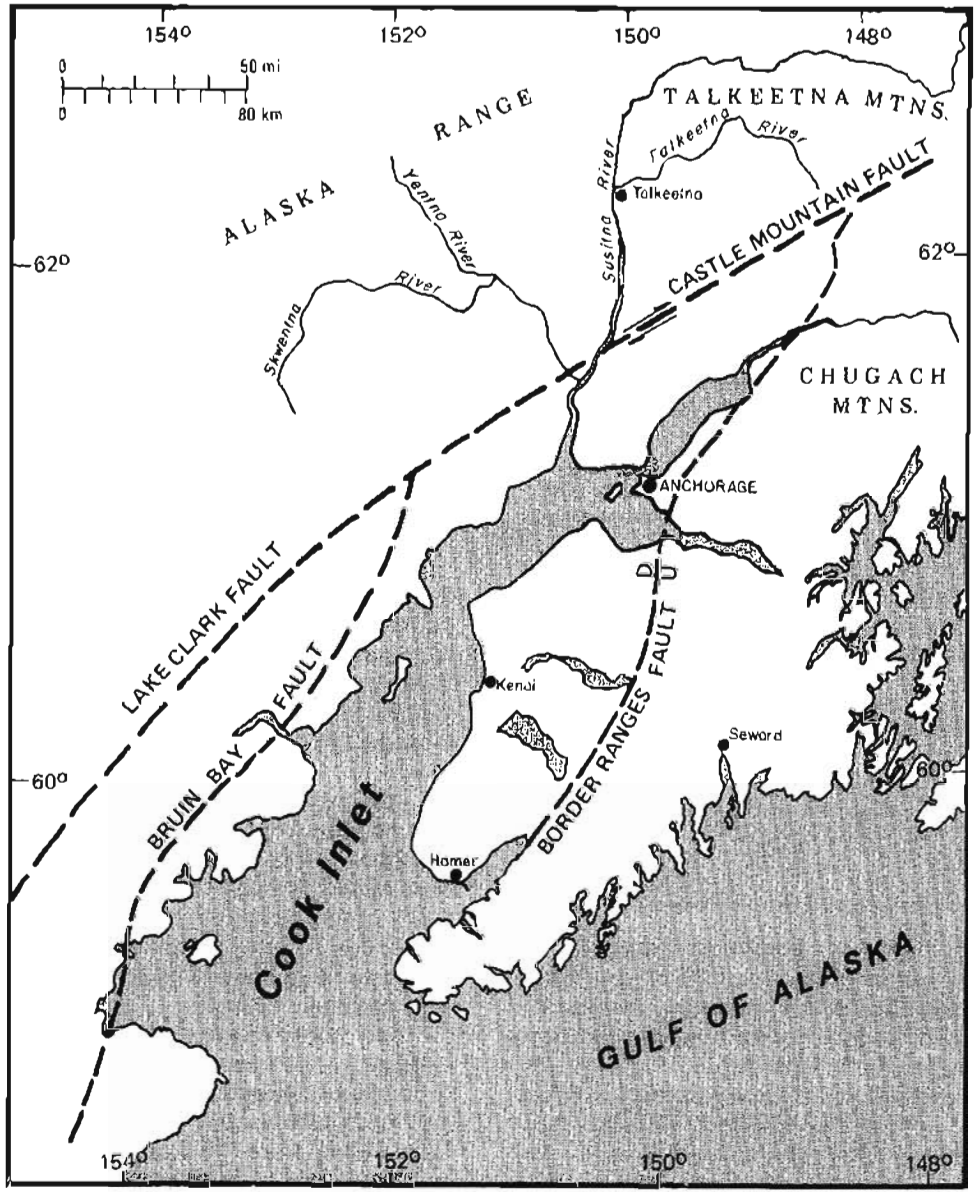

Figure 1. Tectonic setting of Anchorage.

particularly the time frames and extents of specific erosional and depositional episodes, are controversial.

The Bootlegger Cove Formation,[2] which was responsible for the extensive landslides of 1964, consists of stratified clastic sediments ranging from clay to boulders, with thicknesses varying from 30 to 75 m. Microfossil evidence supports marine deposition, although a glacially restricted, brackish environment cannot be disregarded. Radiocarbon dates obtained by Schmoll and others (1972) indicate a late Pleistocene age (>14,000 yr B.P.) for the upper part of the formation. The Bootlegger Cove Formation is generally overlain by 3 to 15 m of stratified outwash sands and gravels deposited during the Naptowne Glaciation. It is underlain by glacial and glaciofluvial silts, sands, and gravels.

[2]Formerly termed 'Bootlegger Cove Clay,' this geologic unit has been renamed a formation by Updike and Carpenter, 1983 (in press).

MECHANICS OF GROUND FAILURE IN THE BOOTLEGGER COVE FORMATION

Numerous old landslides along bluffs and stream valleys in the Anchorage area can often be attributed to instability of the Bootlegger Cove Formation, which underlies much of the western part of the city. The potential for catastrophic failures of the formation was recognized as early as 1959 by Miller and Dob-

rovolny.

Besides stability problems associated with the Bootlegger Cove Formation during the 1964 earthquake, the extreme ground motion and long duration of shaking caused numerous subsidence and gravity-fall failures. More importantly, the induced cyclic shear stresses that developed within the Bootlegger Cove Formation caused landslides near bluffs at several locations in the city.

Two failure mechanisms were pursued rigorously in the literature: a) liquefaction of silts and sands (Seed, 1968, 1976; Seed and Wilson, 1967; Shannon and Wilson, 1964) and b) collapse of sensitive silty clays (Long and George, 1966; Kerr and Drew, 1965, 1968; Hansen, 1965). The 1964 Anchorage landslides have become case histories for both types of failure mechanisms, but no agreement has been reached as to which was primarily responsible or which should be of preeminent concern in the future.

LIQUEFACTION

During an earthquake, soil is subjected to a series of shear stresses that randomly vary in magnitude. If a saturated, cohesionless soil---ideally a well-sorted sand---is subjected to seismically induced cyclic loading, the soil structure tends to become compacted and the resultant stress is then transferred to the pore water. In response, the soil structure rebounds, volume remains constant, and pore-water pressure increases. When the pore pressure equals the confining pressure, a state of 'initial liquefaction' (Seed, 1976) is reached and, if cyclic stress continues, the resulting strain produces 'cyclic mobility' (Casagrande, 1976). Depending on these factors---sand density, confining pressures, and magnitude of the stress cycles---the soil may be mobilized to unlimited deformation or may encounter only limited strain before dilating to a stable condition. If liquefaction occurs at or near the ground surface (as in Niigata, Japan, in 1965), considerable bearing strength is lost and sand flows result. If a quasi-rigid sequence of soils overlies the liquefied sand, the overlying sequence may be laterally displaced for the duration of the cyclic loading and translational block slides can occur. This mechanism has been proposed for the Turnagain Heights and L Street slides (Seed, 1976).

COLLAPSE OF SENSITIVE SOIL STRUCTURES

Certain layers within the Bootlegger Cove Formation are composed of silty clays, which were probably deposited in brackish to saline waters. This deposition is conducive to the formation of an open, flocculated framework of soil particles---in short, a structure that has acquired some degree of internal strength by ionic bonding and precipitate cementation between its intersecting particles. Under high shear stresses, the flocculated structure collapses with an attendant decrease in volume. As a result, if the drainage of pore water is too slow, as in a low-permeability confined zone within the Bootlegger Cove Formation, effective stresses in the zone of collapse approach zero, causing lateral flow and planar gliding. This failure also affects overlying units, and block movement occurs along numerous secondary shear planes.

The soil is considered sensitive if, on remolding, its strength[3] is significantly less than what it was in the undisturbed state. Although the initial movement may closely resemble liquefaction along deep, cohesionless horizons, sensitive-clay failures would likely continue after cessation of the cyclic shear stresses because of the continued loss of shear strength.

The most apparent source of local sensitivity in the Bootlegger Cove Formation is the Quaternary fluctuations of sea level and the associated leaching of salt bonds from the flocculated structure. Mitchell (1960) suggested that thixotropic hardening may also affect sensitivity in remolded zones by reorganizing the balance of the interparticle forces, which would tend to flocculate the particles in a newly established water-cation structure. The limited shear strains encountered during prior seismic events then remold the silty clays along failure planes and serve to expand the sensitive zone vertically.

In fact, where both liquefiable silty sands and sensitive clays occur at or above sea level and seismic loading is high enough to trigger mobilization, both stratigraphic units could fail, as was the case in the Turnagain Heights slide, described below.

THE 1964 LANDSLIDES

Among the numerous ground failures that occurred in Anchorage during the 1964 earthquake were six major slides: a) Turnagain Heights, b) L Street, c) Fourth Avenue, d) Native Hospital, e) Government Hill School, and f) Cherry Hill (fig. 2).

Although each slide had its own distinctive volume, vertical and horizontal displacement, and mechanics of movement, all failures were characterized by low-strength soils at or near sea level and by extensive free faces that fronted on either Knik Arm or Ship Creek (Shannon and Wilson, 1964; Hansen, 1965).

Of the six slides, three---Turnagain Heights, L Street, and Fourth Avenue---had severe impact on commercial and residential development (figs. 3-5). Each was intensely studied shortly after the earthquake and, although experiments in soil stabilization (electro-osmosis and explosives) were conducted, only the Fourth Avenue slide was actually buttressed; the others were simply backfilled and graded.

[3]Relative strength is usually expressed as a ratio between the undisturbed shear strength and the remolded shear strength.

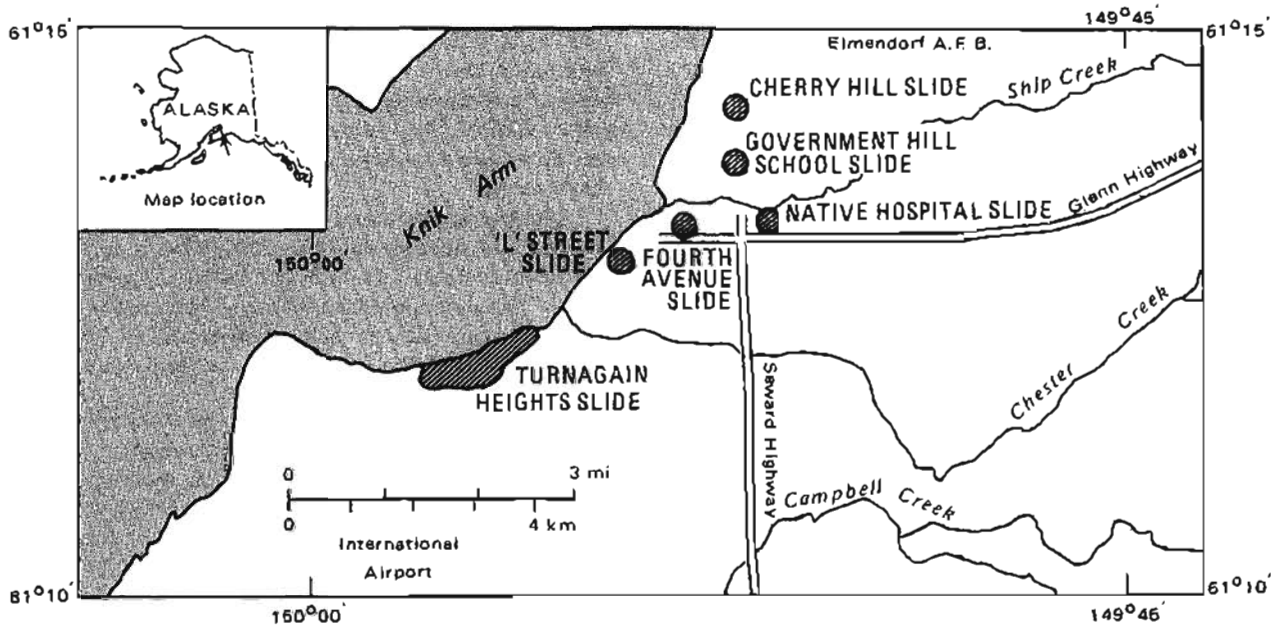

Figure 2. Map of the Anchorage area showing the approximate locations of the 1964 seismic-induced landslides.

INCLINOMETER INSTALLATIONS

Post-1964 earthquake geotechnical studies were conducted primarily by the U.S. Army Corps of Engineers in conjunction with both Shannon and Wilson, Inc., and ACLW Consultant Engineers. Numerous borings were made to collect undisturbed samples for laboratory testing, to conduct in-situ soil tests, and to determine piezometric conditions.

At 25 sites, 3-in.-dia slope inclinometer casings were installed in the boreholes. These specially designed aluminum casings had four machined tracks uniformly spaced at 90-degree intervals. When a sensor was lowered down the casing along the tracks, the orientation of the casing with respect to depth was recorded. The approximate geographic locations of these casings were reported by Shannon and Wilson (1964).

Four additional casings were installed, two adjacent to the Fourth Avenue slide by DOWL Engineers for the Anchorage Municipality in 1977 and two the next year for the USGS in Lynn Ary Park, adjacent to the Turnagain Heights slide area. The approximate positions of the 29 installation sites are given in figures 6-8.

During 1978-1979, I assembled all known documents related to the inclinometer casings and found that within the first 14 months of installation, eight of the sites constructed in 1964 had been lost to grading, burial by fill, or new construction. I then field-checked the sites and found only 10 of the original 25 casings (table 1). Three of these were inaccessible and considered unreliable because post-1965 construction had disrupted the casings. Thus, of 29 total casings, only 11---seven of the original ones and all four new installations---could be reoccupied for this study.

INSTRUMENTS AND PROCEDURES

Each of the 11 inclinometer sites was surveyed with a Sinco Digitilt model C370 inclinometer (instrument 50306). This instrument (fig. 9) has a sensitivity of one part in 10,000 or about 10 sec of arc at 0° inclination. The specification error of measurement in a 100-ft-deep hole should be less than ± 0.2 in. The sensor, containing two servo-accelerometers mounted with their sensitive axes at right angles, was inserted into the casing and lowered along the machined grooves on spring-loaded wheels to the base of the hole by an electrical cable connected to a digital indicator at the surface. The sensor was oriented to follow the casing tracks nearest to the north-south plane. After allowing 10 min for temperature equilibration, the sensor was raised at 2-ft intervals from the base of the hole and readings were recorded at each interval for both the north-south and east-west axes. When the sensor reached the top of the casing it was removed, rotated 180 degrees, and reinserted to the bottom of the hole for a second series of measurements. The numbers recorded by this procedure are equal to 2 sineθ, where θ equals the inclination (in degrees) of the sensor from vertical (0°). Algebraic signs denote inclination toward the north (+) or south (-), east (+) or west (-). The algebraic difference between the two sets of readings (ΔNS and ΔEW) were used to compute casing inclination, for example, θ in the north-south plane:

$$\theta \text{ (degrees)} = \sin^{-1} \frac{\Delta NS}{4 \times 10^4}$$

Figure 3. Turnagain Heights area immediately following 1964 earthquake. Intersection of Turnagain Parkway and McCollie Avenue, looking west. Location is within 200 m of inclinometer sites C1B, CB5, and CB3. (Photograph from NOAA-EDIS files.)

For any depth the north-south lateral deflection of the top of the sensor with respect to the bottom of the sensor (24-in. spacing) was computed by:

$$\text{Deflection (in.)} = 24 \sin\theta = 24\left(\frac{\Delta NS}{4 \times 10^4}\right) = 6 \times 10^{-4} \times \Delta NS$$

This same procedure was followed for east-west deflection by substituting ΔEW for ΔNS, and the computed results were denoted by deflection (DEFL). When plotted graphically against depth, the cumulative sum of DEFL gave an accurate representation of the configuration of the casing in the north-south and east-west planes. In addition, the data can be compared to previous data sets to determine the past behavior of the casing. Appendix A shows the north-south and east-west profiles of the 11 casings as represented by the data acquired in this survey.

COMPARISON WITH PREVIOUS DATA SETS

During the first few weeks following the installation of the inclinometer casings in 1964, several sets of readings were taken, apparently because of concern over continued strain in the slide zones. The casings not lost to reconstruction were measured again in June 1965 and, except for readings on two casings in the Fourth Avenue slide area, were not surveyed again. Fortunately,

Table 1. *Status of slope inclinometer casings, December 1980.*

Hole	Installation by	History of readings	Status of data on file	Status of hole	Comments
A1A	ACLW for City	1964-65	Initial, 1965	Lost to mall construction	
A2A	"	1964-65, 1977-79	All data	Intact	Modified during buttress construction
A3A	"	1964-65 1977-79	All data	"	"
A4A	"	1964-65	Initial, 8/64, 1965	Lost to new construction	Casing cut 3.5 ft below top, 7/10/64
A5A	"	1964-65, 1979	" "	Intact	Casing cut 3 ft below top, 6/18/64; some damage to top of casing
A106S	Shannon & Wilson	1964-65	"	Present but inaccessible	Manhole cover sealed; casing cut 1.5 ft below top, 6/5/64
B-1	ACLW for City	1964-65, 1979	"	Intact	Casing cut 1.5 ft below top, 7/21/64
B-2	"	1964-65	"	Lost to grading and fill after 1965	Casing cut 5 ft below top, 7/21/64
B-3	"	"	"	"	Casing cut 2 ft below top, 7/10/64
B-4	ACLW for City	1964-79	Initial, 7/64	Intact	1965 data thought to be lost
B-101	Shannon & Wilson	1964-65, 1979	8/64 (initial), 1965	"	Early reading unreliable; casings cut 5 ft below top, 6/15/64
B-106	"	1964	7/64	Lost in 1964; buried by fill	One reading only; poor data; lost before 8/22/64
B-113	"	1964-65	Initial, 8/64. 6/65	Lost to construction of L St building	Presumed lost
C1B	ACLW for City	1964	Initial, mid-1964	Lost to grading, 1964	Regard data as poor, casing cut 5 ft below top, 7/21/64
C-100	Shannon & Wilson	1964-65	Initial, mid-1964 -65	Lost after 1965	Very close to scarp; casing cut 3 ft below top, 6/5/64

C-102	"	1964	Initial-1964, mid-1964 only	Lost to rock fill, 1964	Casing cut 5 ft below top, 6/5/64
C-103	"	1964-65	Initial, 1965	Lost after 1965	
C-104	"	1964	Initial only	Buried by fill, 1964	Poor reliability
C-105	"	"	"	Lost to sewer installation, 1964	Lost before reading history developed
C-109	"	1964-65	Initial, 8/64, 6/4/65	Located but closed 3 ft below surface	Errors between readings
C-115	"	1964	Initial, 8/64	Lost to sewer installation, 1964	Short data period
C-124	"	1964-65	Initial, 8/64, 1965	Lost to grading, 1965	"
C-130	"	"	"	Located but sealed below surface unrecoverable	7/20/64 data computed by S&W not accurate; problems with casing top in 1964-65
C-134	"	1964-65, 1979	"	Intact but closed at 44 ft; unrecoverable	No problems to 151 ft in 1965; top of casing loose, 1965; lost in recovery attempt, 1980
C-101	"	1964	1964 only	Lost to sewer installation, 1964	Casing cut 2 ft below top on 6/5/64
A-112S	DOWL	1977-78	1977-78	Closed with rubbish 10 ft below surface; unrecoverable	Lost to casing obstruction
A-1005S	"	1977-79	1977-79	Intact	
USGS B-3	DOWL for USGS	1979	New hole, 1979	Open to 52 ft	Small-dia casing; slurry filling to 53-ft depth
USGS B-5	"	1979-80	New hole, 1979-80	Open to 54 ft; reopened to 70 ft, 1980	Large-dia casing, slurry to 55-ft depth cleared in 1980

Figure 4. Fourth Avenue slide area, downtown Anchorage, immediately following 1964 earthquake. View is north side of Fourth Avenue. (Photograph from NOAA-EDIS files.)

the U.S. Army Corp of Engineers retained records of these measurements.

The 1964-65 measurements were made with a 20-in.-long Sinco series 220B inclinometer, whereas post-1975 readings were made with the Digitilt C370 inclinometer, which is 4 in. longer. As a result, procedures for the older instrument specify measurements at different intervals than those specified for the C370. In addition, the former instruments have a specified accuracy to three decimal places, whereas the Digitilt records to four. However, both instruments record data that are equated to the inclination angle of the instrument at a given depth and, even though the depth interval may be different, each records the orientation of the casing in three-dimensional space relative to the vertical.

To directly compare the various data sets, the new data were rounded from four to three decimal places, the original (1964-65) depth intervals were retained, and each site was evaluated with respect to history of readings, problems encountered in takings those readings, modifications to the casings, and unusual variations among the data sets that could indicate less confidence in a given set. When possible, three of the early data sets were used for comparison: a) the earliest reliable set after installation, used as the initial readings for this study, b) the latest reliable 1964 set, generally recorded in late summer, and c) the 1965 set on the casings that were still intact. Where the new data values are at different depths than those of the 1964-65 sets, the new values were interpolated to the earlier interval depths. For example, to compare a new value with an earlier

Figure 5 Oblique aerial photograph of the Fourth Avenue Slide area, 1979. The Fourth Avenue buttress, constructed after the 1964 earthquake, in center. (Photograph by R.G Updike, 1979.)

depth of 7.5 ft, interpolation was made between the 6- and 8-ft values of the new data. The author described this technique to D. Shoup, senior electronics engineer, Slope Indicator Company, who confirmed the viability of the technique (written commun., 1980). The older data sets are in Appendix B, along with the interpolated new values.

Deflection from the initial readings for selected depths was plotted to demonstrate postinstallation movement of the casing. Plots for each of the casings are given in Appendix C.

Three general causes can be identified to account for divergences from the initial line: a) the casing moved in the borehole after the initial reading, with little or no corresponding movement of the surrounding soils, b) instrument measurement error was introduced and maintained throughout the readings, and c) actual strain of the surrounding soils occurred after the initial readings.

The actual cause of the variation can generally be determined by comparing the deflection profiles of the casing. For the first case, each of the postinitial deflection profiles would be in close agreement with or at most would show only minor variation over the length of the casings. The second case would not show a single spurious deflection profile but would be in close agreement with the other profiles for that casing. In the third case, either the deflection profile would consistently change from one set to the next or an abrupt change would register on subsequent readings.

However, the Digitilt inclinometer is accurate to within ± 0.2 in. per 100 ft, and incremental deflections within instrument accuracy cannot be confidently ascribed to actual casing displacement. The horizontal scale used in plots of Appendix C is actual deflection from the initial calibration profile.

On the basis of the above constraints, only two casings, A2A and A3A, show post-1964 strain. Moreover, both showed strain in both the north-south and east-west directions. Six other casings may show post-

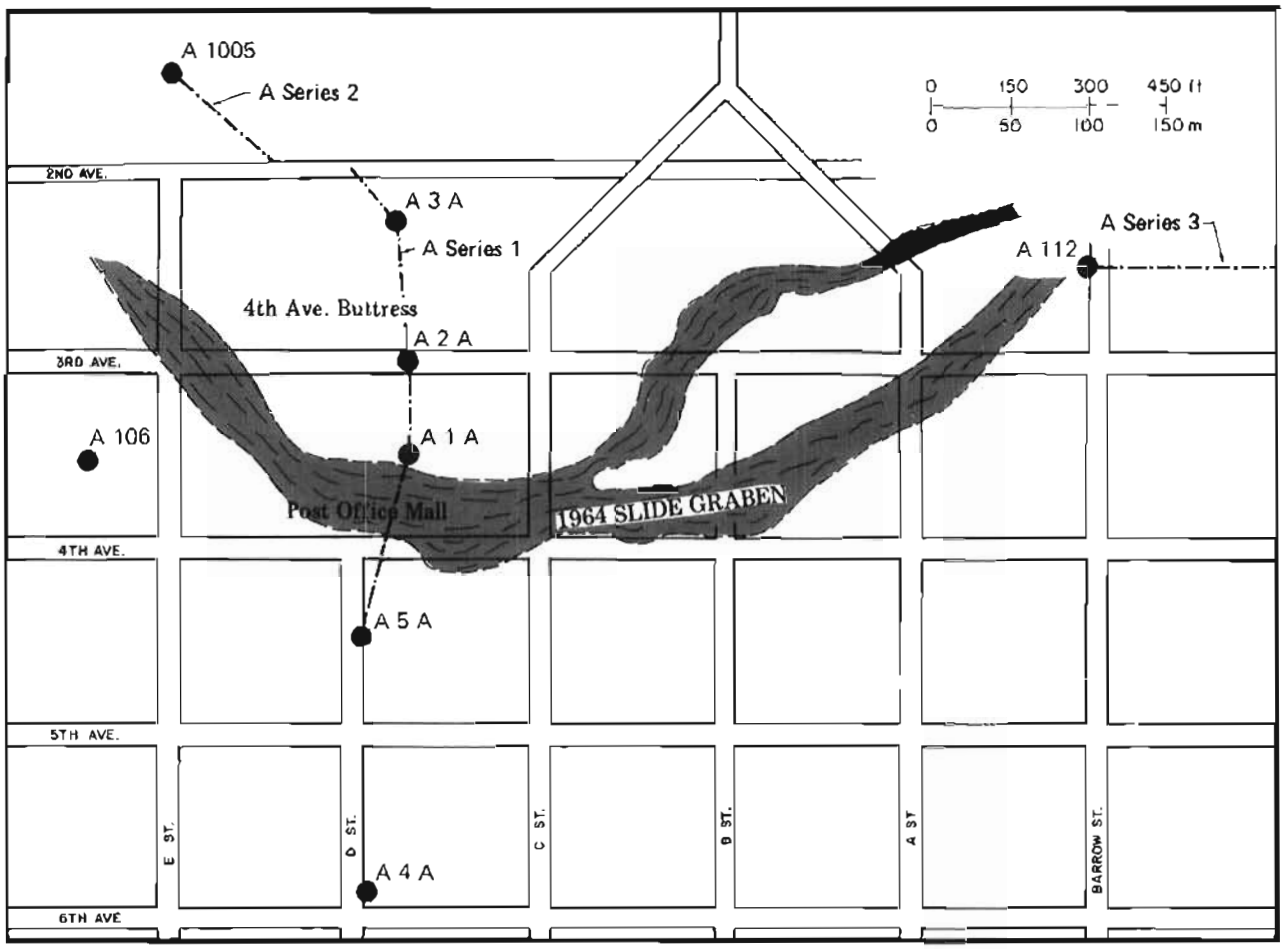

Figure 6 Map showing the location of slope-indicator casings associated with the Fourth Avenue slide. Lateral displacement was primarily north of the indicated graben, with movement toward the north. Cross-section lines for figures 10-12 are indicated by the dashed series lines.

installation strain. Table 2 assesses the deflection curves (Appendix C). Although the early loss of many sites precluded measurement of post-1965 behavior, there are enough sites left in and around the Fourth Avenue slide area and west of the L Street slide to draw the following conclusions.

CORRELATION OF DATA WITH SUBSURFACE GEOLOGY

The Bootlegger Cove Formation is composed of at least seven geologic facies (Updike and Carpenter, 1983; Updike, 1983). All may not occur at a given locality, and both thickness and stratigraphic position will vary laterally. Also, each facies has its own suite of engineering characteristics (table 3). Within the range of characteristics for facies F. IV (the most common), subtleties that may eventually necessitate a revision of the defined-facies suite have repeatedly emerged; these variations are termed 'subfacies' (table 3).

The seven engineering geologic facies of the Bootlegger Cove Formation are mappable in three dimensions. This has immediate value to the engineer who is concerned about subsurface soil conditions at a given locality and provides geologists with a better understanding of the Quaternary history of the region.

Five facies are cohesive, two are not. The latter (F.VI and F.VIII) are susceptible to liquefaction if other criteria are satisfied (for example, ground-water conditions, effective overburden pressure, or state of confinement).

Of the five cohesive units, only F.III is of significant concern because of its relatively high sensitivity (mean sensitivity ratio = 19). The in-situ static shear strength of F.III is similar to that of the other cohesive facies, but when disturbed its strength drops markedly. The presence of facies F.III, F.VI, and F.VII beneath the bluff areas of Anchorage intimates the potential for failures due to both liquefaction and sensitive clay.

To assess the relationship of the slope-indicator

Table 2. *Assessment of causes for deflection curves presented in Appendix C.*

Negligible deflection	Postinstallation adjustment	Measurement error	Probable soil strain	Soil strain
A106 - N/S	A4A - N/S	A5A - N/S	A1A - N/S	A2A - N/S
A106 - E/W	A4A - E/W	C109 - E/W	A1A - E/W	A2A - E/W
A112 - N/S	B1 - N/S	C134 - N/S	B1 - E/W	A3A - N/S
A112 - E/W	B2 - N/S	C134 - E/W	B4 - E/W	A3A - E/W
A1005 - N/S	B2 - E/W		C1B - N/S	
A1005 - E/W	B3 - N/S		C1B - E/W	
B101 - N/S	B3 - E/W		C103 - N/S	
B101 - E/W	B4 - N/S		C103 - E/W	
C130 - N/S	B113 - N/S		C109 - N/S	
C130 - E/W	B113 - E/W			
	C100 - N/S			
	C100 - E/W			

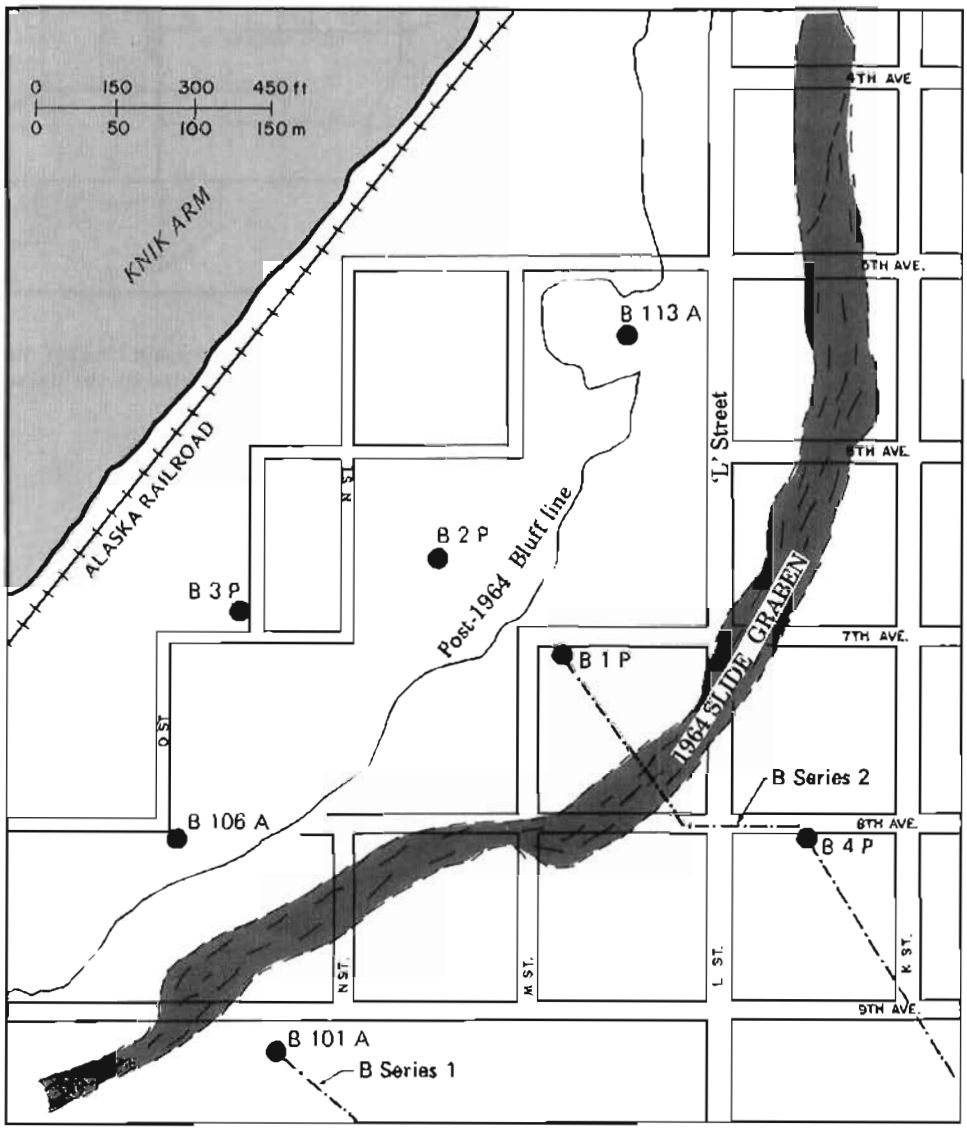

Figure 7. Map showing the location of slope-indicator casings associated with the L Street slide. The 1964 earthquake slide movement was west of the indicated graben, generally with a dominantly horizontal vector to the northwest. Cross-section lines for figures 13 and 14 are indicated by the dashed series line

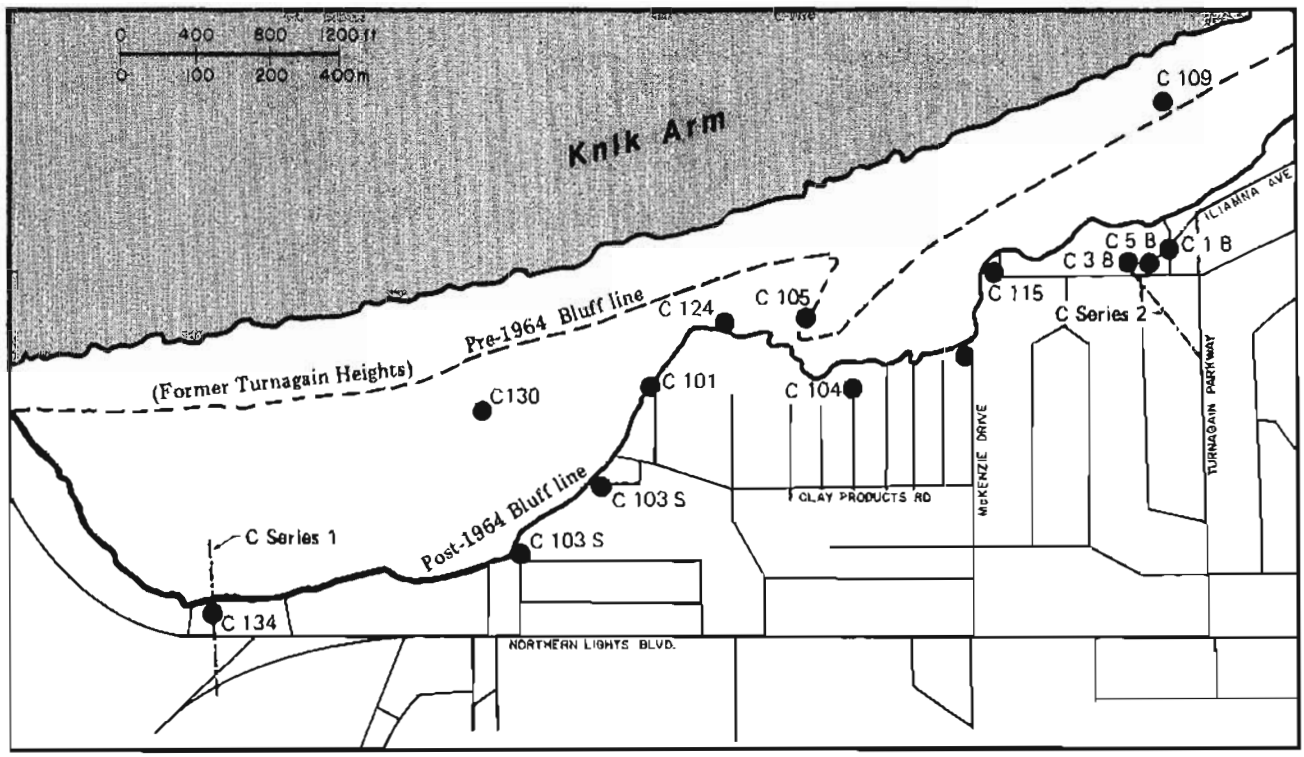

Figure 8. Map showing the location of slope-indicator casings associated with the Turnagain Heights slide. Displacement was generally north to northwest. Cross-section lines of figures 15 and 16 are indicated by the dashed series line.

Table 3. *Index to symbols used in figures 10-16, logs and composite profiles.*

Unified soil classification units

GP - Poorly graded gravels or gravel-sand mixtures, little or no fines
SP - Poorly graded sands or gravelly sands, little or no fines
OL - Organic silts and organic silty clays of low plasticity.

Engineering geologic facies of the Bootlegger Cove Formation

I - Facies I: Clay with very minor amounts of silt and sand
II - Facies II: Silty clay or clayey silt
III - Facies III: Silty clay or clayey silt, sensitive
IV - Facies IV: Silty clay or clayey silt with thin silt and sand lenses
IVA - Subfacies F. IVA: Silty clay and clayey silt with silt and fine sand lenses
IVB - Subfacies F. IVB: Silty clay with traces of coarse sand
IVC - Subfacies F. IVC: Sandy clayey silt
V - Facies V: Silty clay or clayey silt with random pebbles
VI - Facies VI: Dense, silty fine sand with silt and clay layers
VII - Facies VII: Fine- to medium-grained sand with traces of silt and gravel.

Slope-indicator variations

■ Installation inflections
▲ Strain inflections, doubled where strain in both directions
Postinstallation obstruction.

casings to the local stratigraphy, I reexamined geotechnical borehole logs near each of the three major slides and reinterpreted the stratigraphy in terms of the seven facies on the basis of the original logs and engineering test data.

To gain stratigraphic control on the casing and environs, boreholes drilled at or near to slope-indicator casings were selected for reexamination. The geotechnical holes were reinterpreted according to facies, and idealized stratigraphic cross sections were constructed through the slope-indicator casing sites (figs. 10-16). The records of each casing were then examined to determine if casing variations could be attributed to soil stratigraphy. Particular attention was given to inflections in casing profiles (depth, direction, magnitude) and to depths at which deflections occurred (table 2).

The engineering geologic facies and the history of

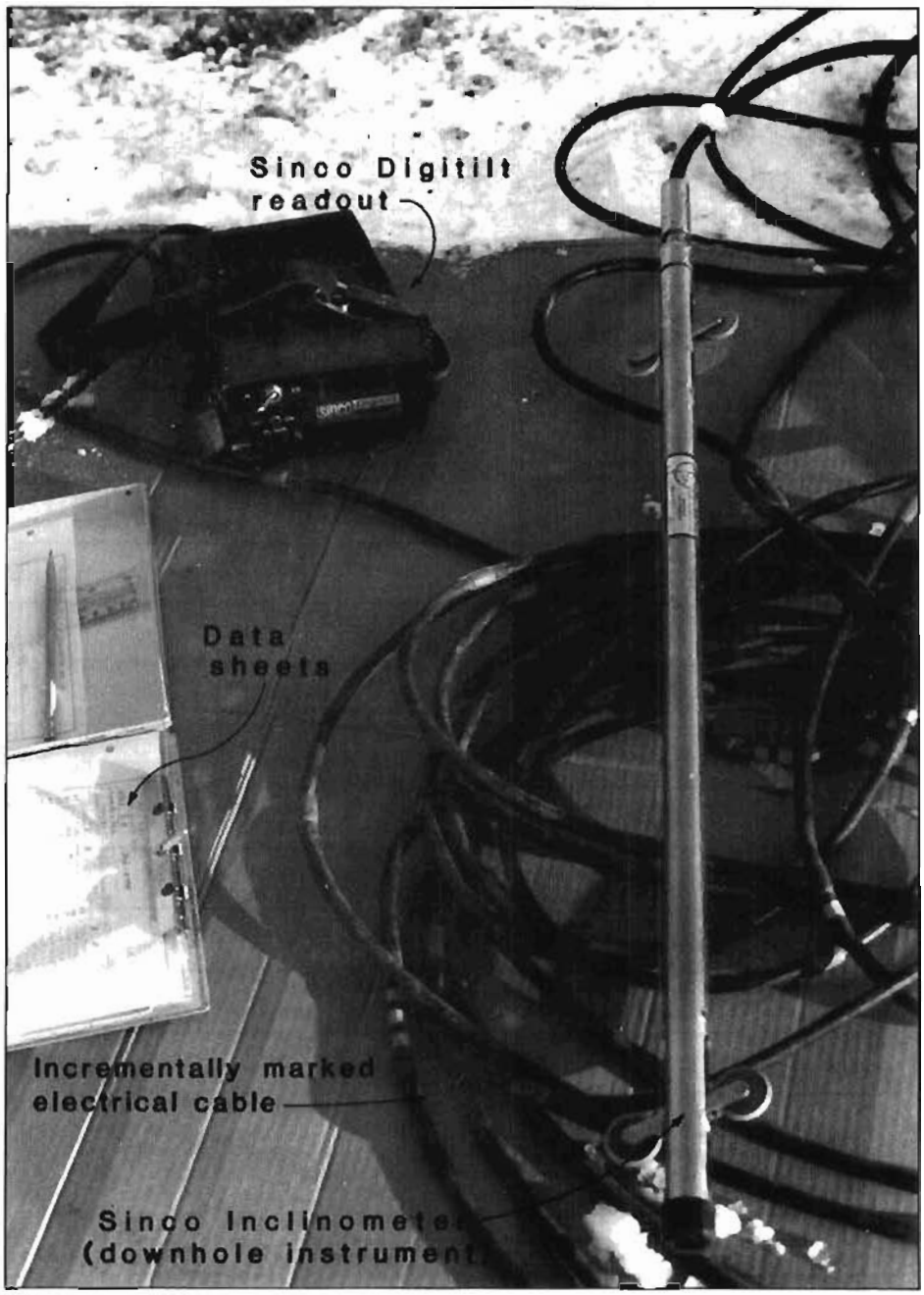

Figure 9. Sinco Digitilt slope inclinometer. (Photograph by R.G. Updike, 1980.)

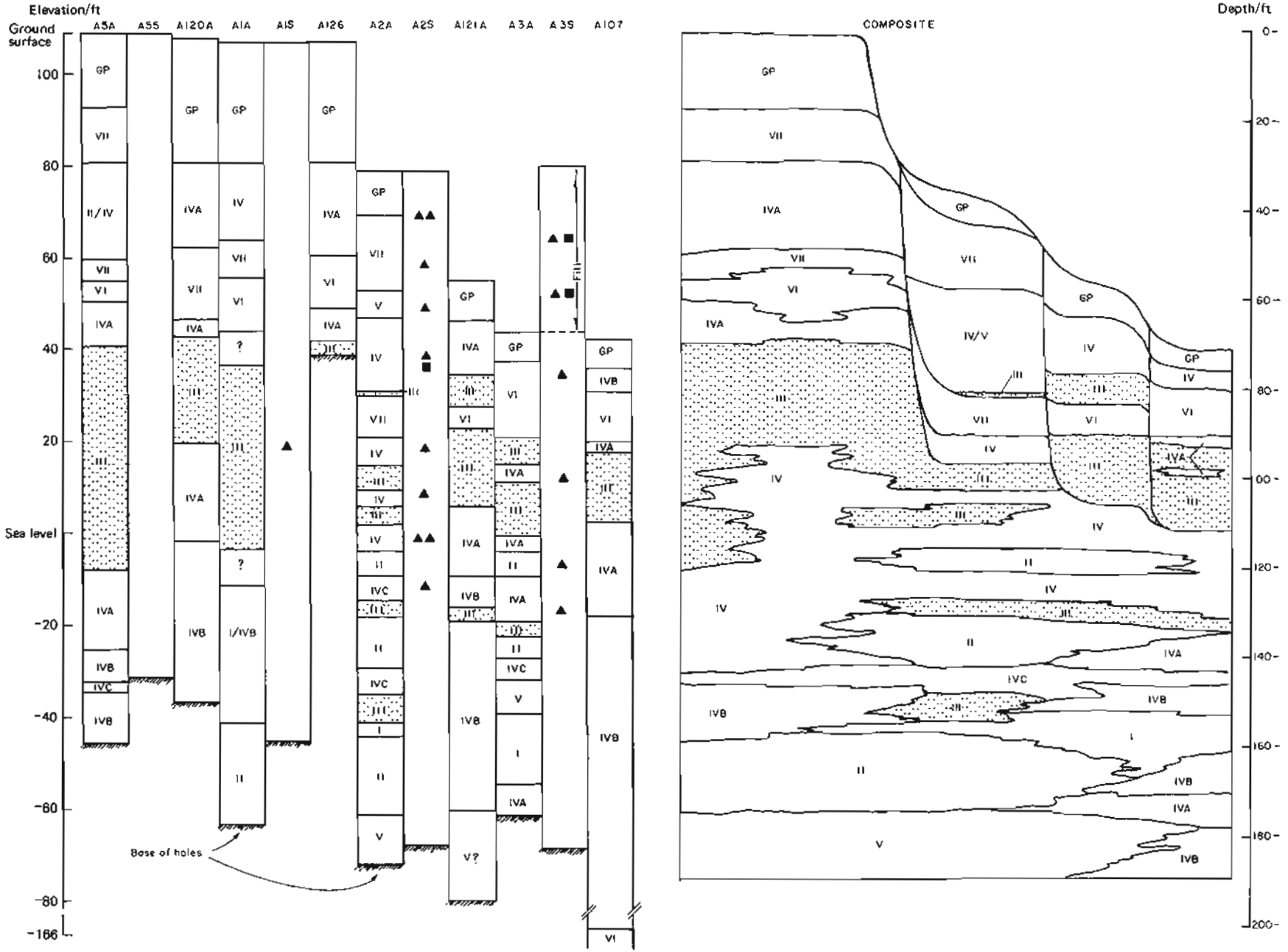

Figure 10. Borehole logs for sites at and near slope inclinometer site A series 1, Fourth Avenue slide zone (fig. 6). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

the inclinometer casings may be linked in two ways: a) facies transitions---for example, transition from a clayey silt (F.IV) to a sensitive silty clay (F.III)---could have caused minor bending or kinking of the casings during installation, or b) postinstallation strain in certain horizons may have deformed the casings. The latter strain could in turn be attributed either to continued movement along shear zones caused by the 1964 earthquake or to instability within facies that had not previously failed. Table 3 defines symbols used to denote casing irregularities; the symbols are plotted at the appropriate depths in figures 10-16.

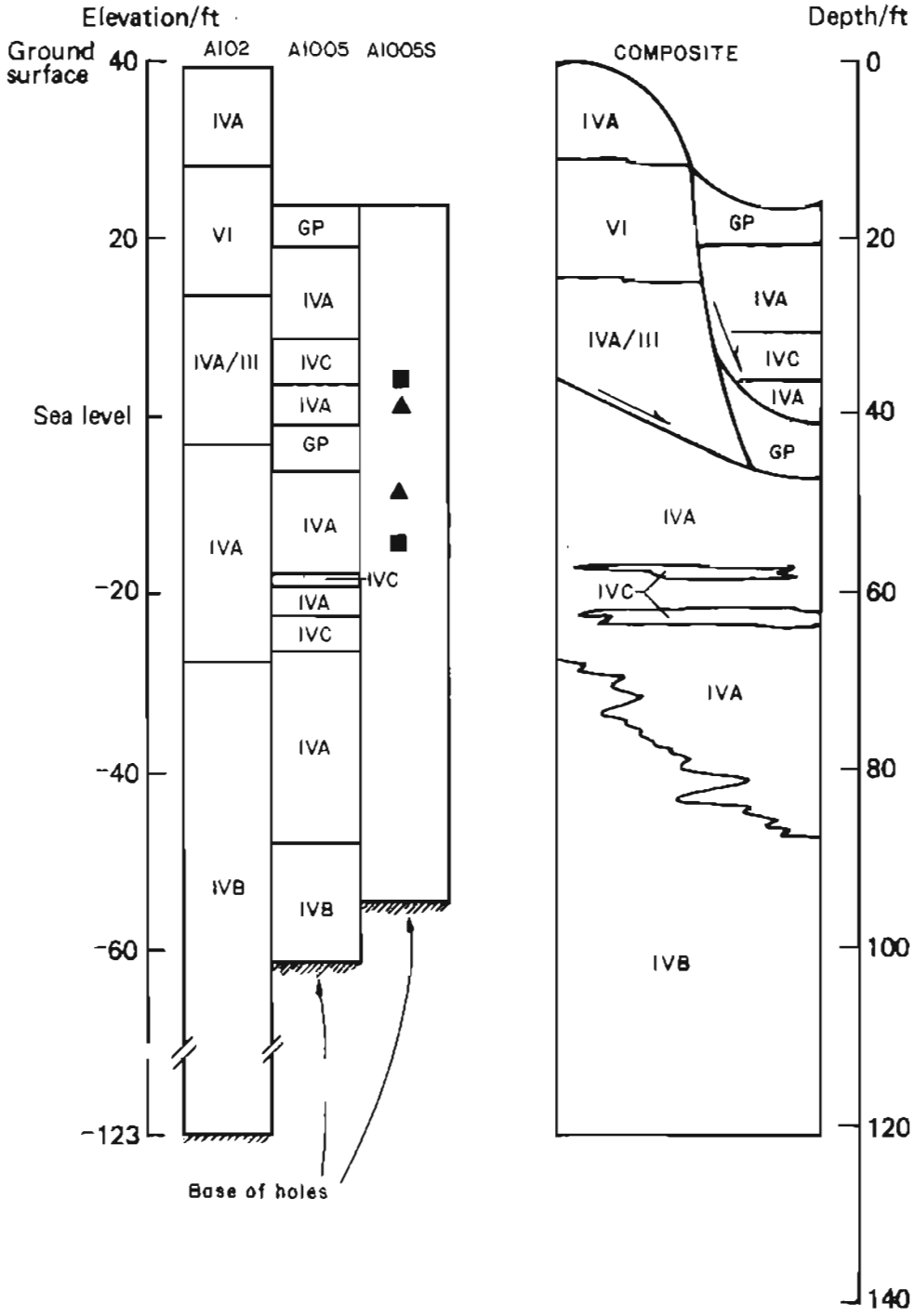

Figure 11. Borehole logs for sites at and near slope inclinometer site A1005, A series 2, Fourth Avenue slide zone (fig. 6). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

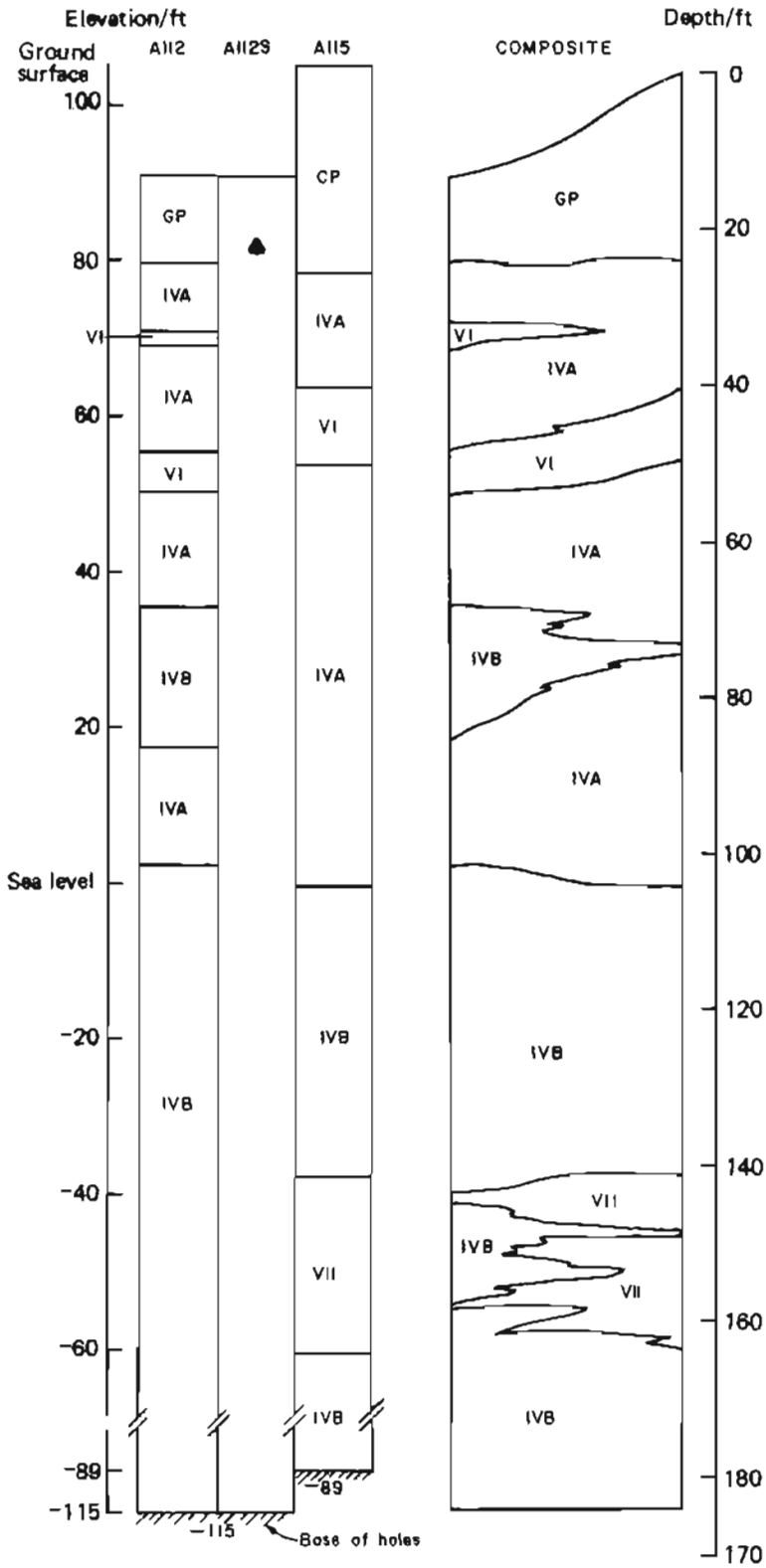

Figure 12. Borehole logs for sites at and near slope inclinometer site A112, A series 3, Fourth Avenue slide zone (fig. 6) Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

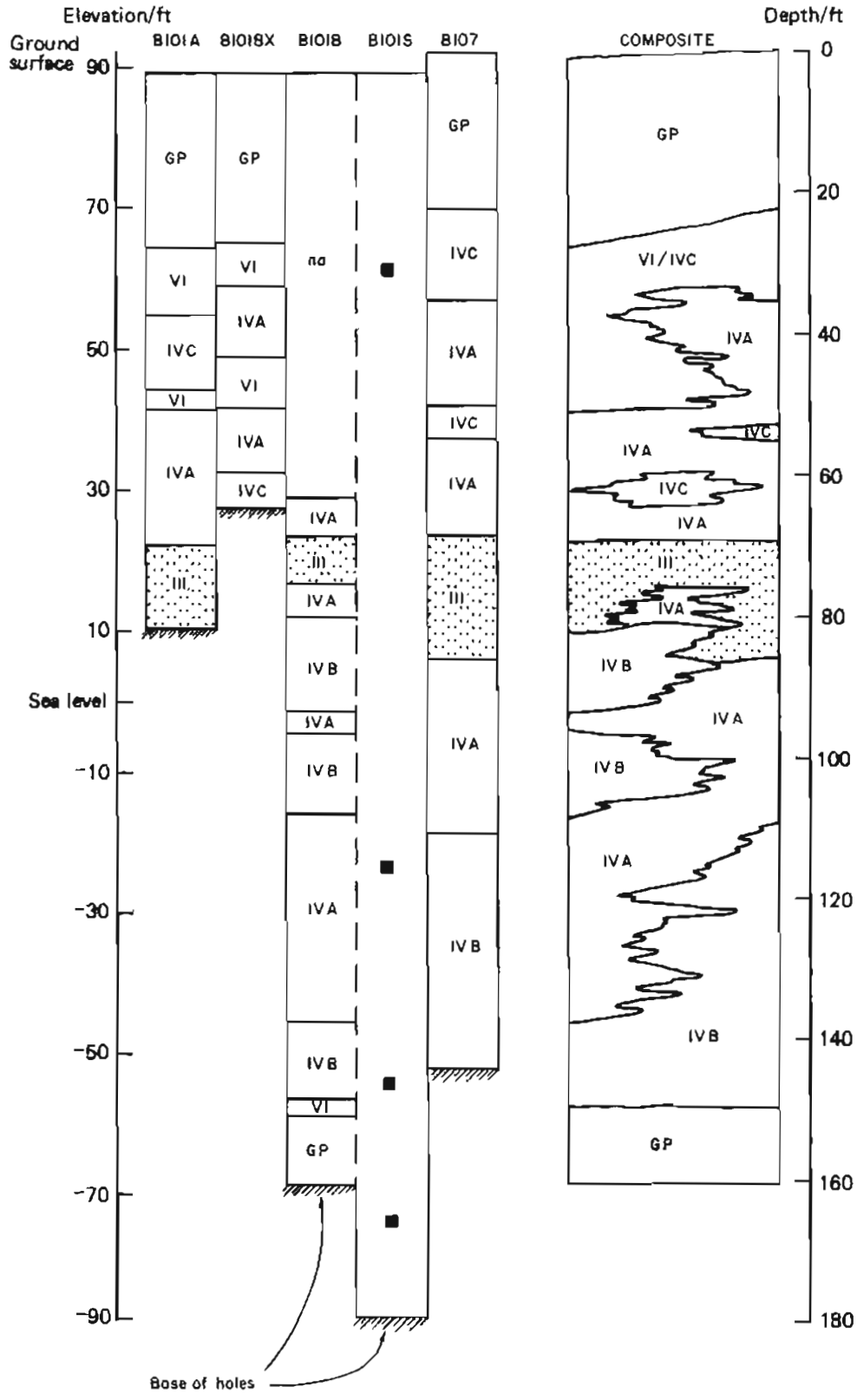

Figure 13. Borehole logs for sites at and near slope inclinometer site B101, B series 1, L Street slide zone (fig. 7). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

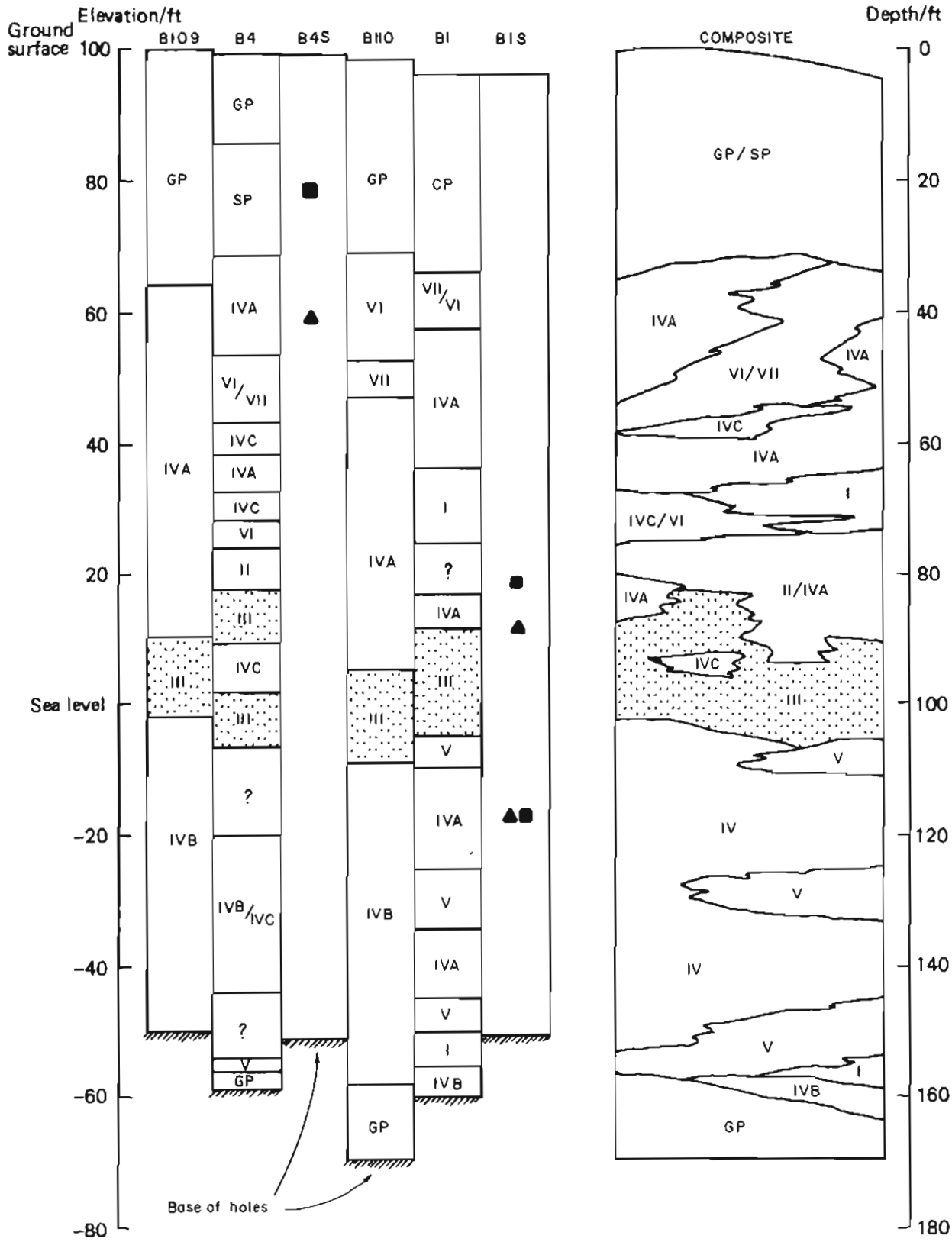

Figure 14. Borehole logs for sites at or near slope inclinometer sites B1 and B4, B series 2, L Street slide zone (fig. 7). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology)

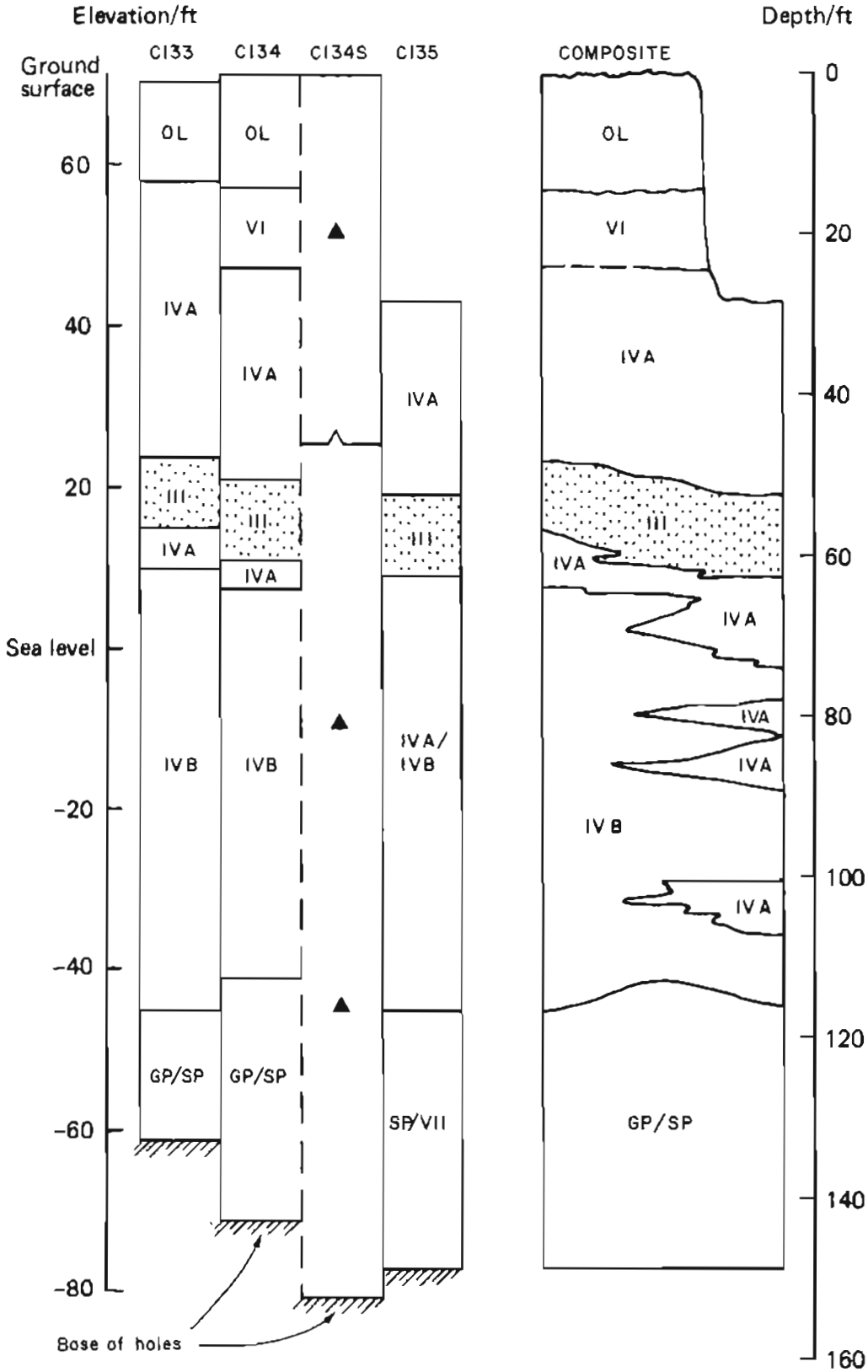

Figure 15. Borehole logs for sites at or near slope inclinometer site C134, C series 1, Turnagain Heights slide zone (fig. 8). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

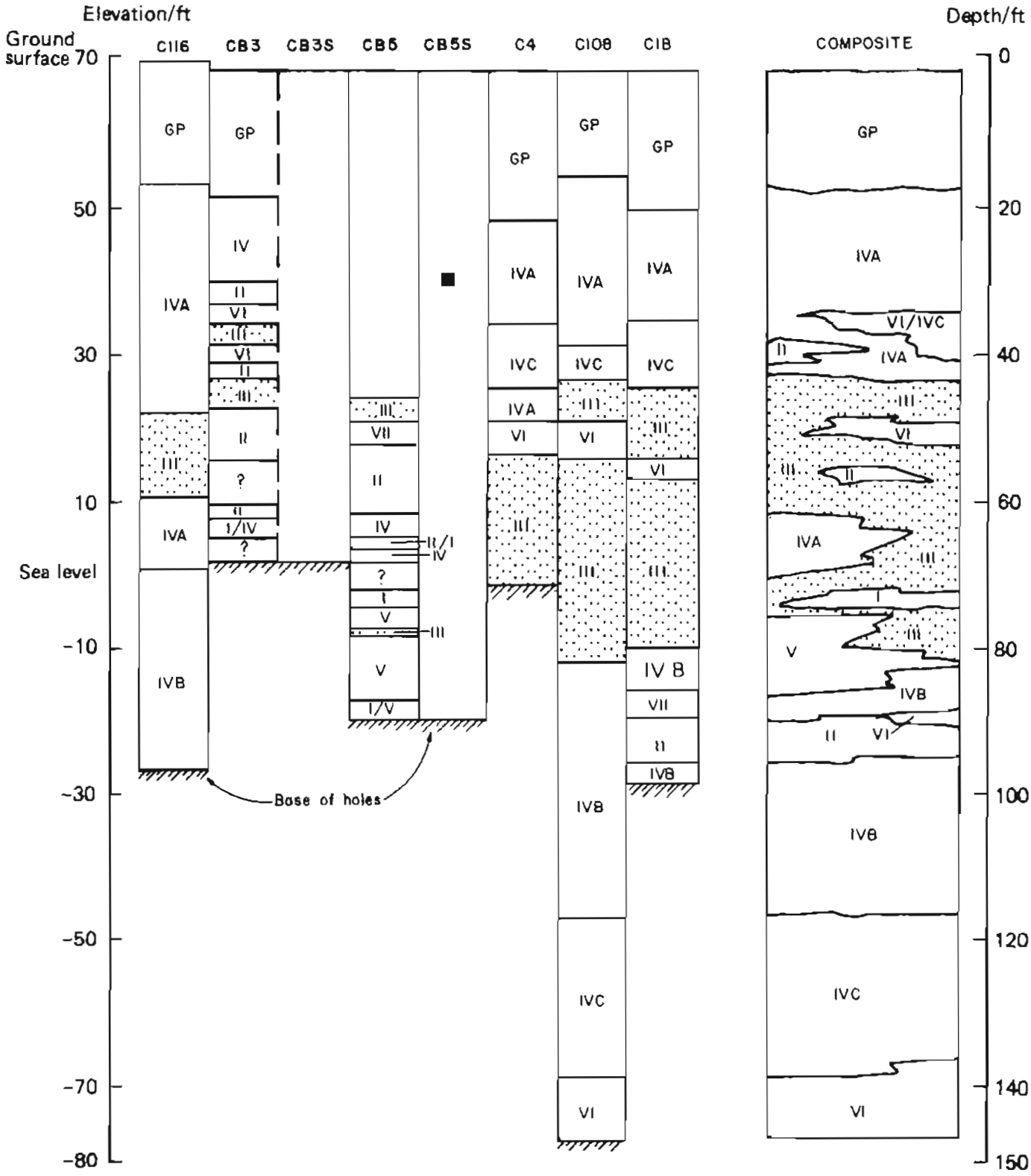

Figure 16. Borehole logs for sites at or near slope inclinometer site CB3 and CB5, C series 2, Turnagain Heights slide zone (fig. 8). Composite cross section at right interpreted from borehole logs. (See table 3 for symbology.)

FOURTH AVENUE SLIDE

Figure 10 shows that the inflections of A series 1 are essentially limited to the slide zone; the composite cross section suggests that the base of the failure zone correlates with a massive F.III zone. Noncohesive facies appear to have been dislocated downslope, but the stratigraphy remained intact at the casing site. Although the inflections are tied to a variety of facies conditions, an inflection in F.III is recorded in three of the four casings 15 to 20 ft above mean sea level, the probable failure zone for the Fourth Avenue slide. Other inflections in A2S and A3S occur near the F.III zones. A series 2 also shows evidence of irregularities, both on installation and afterwards, at the probable depth of shear (composite section, fig. 10). The only inflection observed in A series 3, where there is an apparent absence of F.III and lack of shear zones, occurs at the very top of the formation (fig. 12).

L STREET SLIDE

Composite B series 1 and 2 drawn for the L Street slide area (figs. 13 and 14) indicate that F.III is present from about 15 to 20 ft above sea level, but is far more restricted than that in the Fourth Avenue slide area. The sand facies are also restricted primarily to the uppermost part of the formation. Casings in the L Street slide area reveal little indication of significant deformation, and only in inclinometer B1S is there a correlation between an inflection and F.III. Installation inflections occur in the uppermost part of the formation, probably because of the transition from overlying sandy gravels into fine sand.

TURNAGAIN HEIGHTS SLIDE

Composite C series 1 (fig. 15) is drawn in the area of Turnagain Heights that is now known as Earthquake Park. Although the lateral correlation of F.III is excellent, no inflections are apparent. The obstruction at +25 ft was man-introduced debris; the other inflections mark the upper and lower transitions of the formation. Near Lynn Ary Park, composite C series 2 shows that F.III is abundant from -15 to +25 ft from mean sea level, although it is intercalated extensively with other facies. Casings CB3S and CB5S backfilled with clayey silt to an elevation of about +25 ft within a few months after installation, which suggests a high mobility within the zone dominated by F.III. Facies F.VI is directly adjacent to F.III and may act as a confined aquifer that provides fresh water flow to the sensitive zone.

CONCLUSIONS

The study served two primary functions. First, it established a baseline for the configuration of the slope inclinometer casings relative to the engineering geologic facies of the Bootlegger Cove Formation. Second, the study compared data compiled over a 15-yr period for possible strain in the casings installed in the sites of the L Street, Turnagain Heights, and Fourth Avenue landslides. The three slide zones have remained remarkably stable since the 1964 earthquake.

The L Street slide area, which has been extensively developed since the 1964 event, shows no evidence of even minor displacement behind the present bluff line.

Slope-inclinometer installations that have survived since 1965 in the Turnagain Heights slide zone are far more sketchy; there is strong evidence for potential mobility at elevations from -5 to +30 ft from mean sea level, although the slide site seems to remain unaltered.

The Fourth Avenue slide zone also shows stability behind the 1964 scarp, although the so-called buttress area north of the Post Office Mall may be of some concern. Comparing 1976-80 data with the 1964-65 records for casings A2A and A3A indicates that several zones of strain occurred. Some of the strain may be attributed to 1965-76 construction; however, the considerable depths at which deflections have occurred are far beyond those that would be affected by near-surface disturbance. Further, the zones of deflections have a very strong correlation with facies F.III and F.IV. The 1976 and 1980 records show little evidence of further strain, which implies that the strain has, at least in recent years, ceased. Concern for this area remains significant. The casings here, particularly Nos. A5 and A1005, should continue to be monitored, particularly after future strong-motion seismic events.

Unfortunately, most of the casings installed after the 1964 earthquake were lost to construction. The remaining sites should be preserved and monitored periodically.

ACKNOWLEDGMENTS

I thank R.D. Reger, S.E. Rawlinson, and J.E. Decker for their careful review of the manuscript, and M.E. Pritchard and G.D. Olsen for their graphics. I thank the U.S. Army Corps of Engineers for providing access to their extensive files of historic data. The State of Alaska Department of Transportation and Public Facilities provided me with Sinco Digitilt Inclinometer equipment. The project was funded under a cooperative agreement between the Alaska DGGS and the U.S. Geological Survey Earthquake Hazards Reduction Program.

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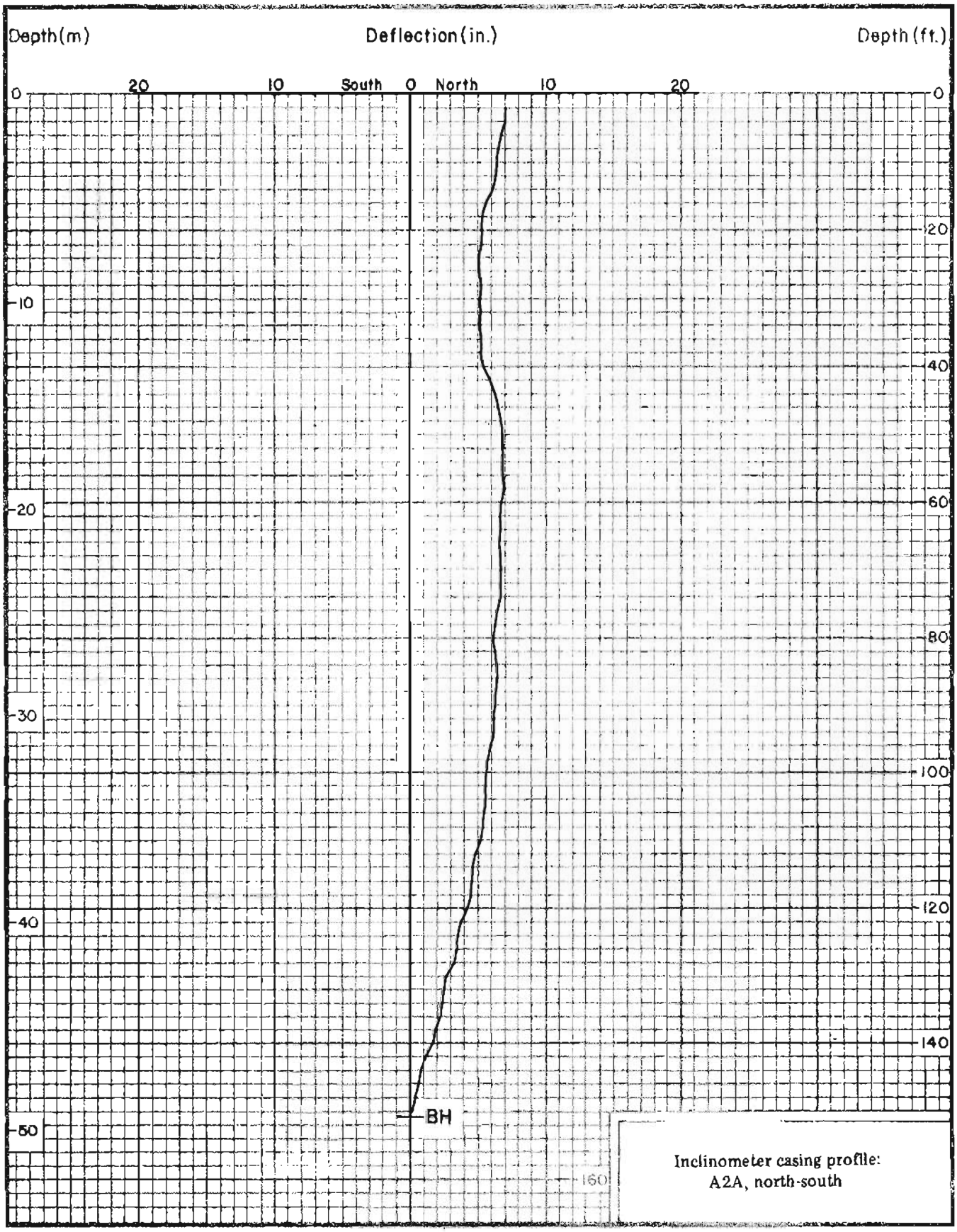
Appendix A

CASING PROFILES, 1979-80

The following figures present the north-south and east-west casing profiles for those slope inclinometer casings that remained in existence in 1979 and 1980.

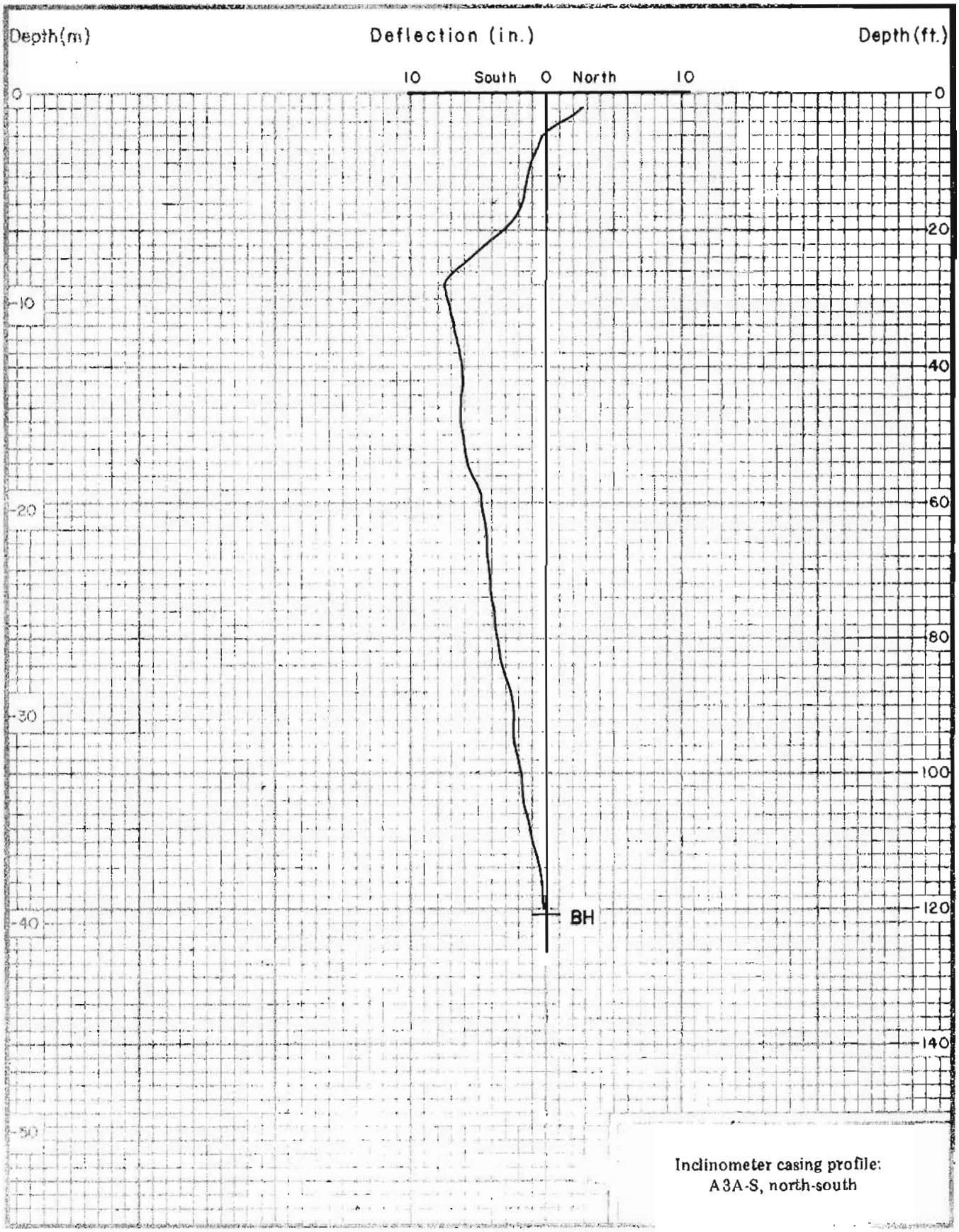
Each profile was obtained by the author, who used a Sinco Digitilt Inclinometer, Model C370 (instrument 50306), which was borrowed from the Alaska Department of Transportation and Public Facilities. The method of data acquisition and derivation of the following profiles is discussed in the text.

Each curve shows the deflection of the casing, in inches, relative to the base of the hole (BH), and is plotted with respect to depth below the existing grade.

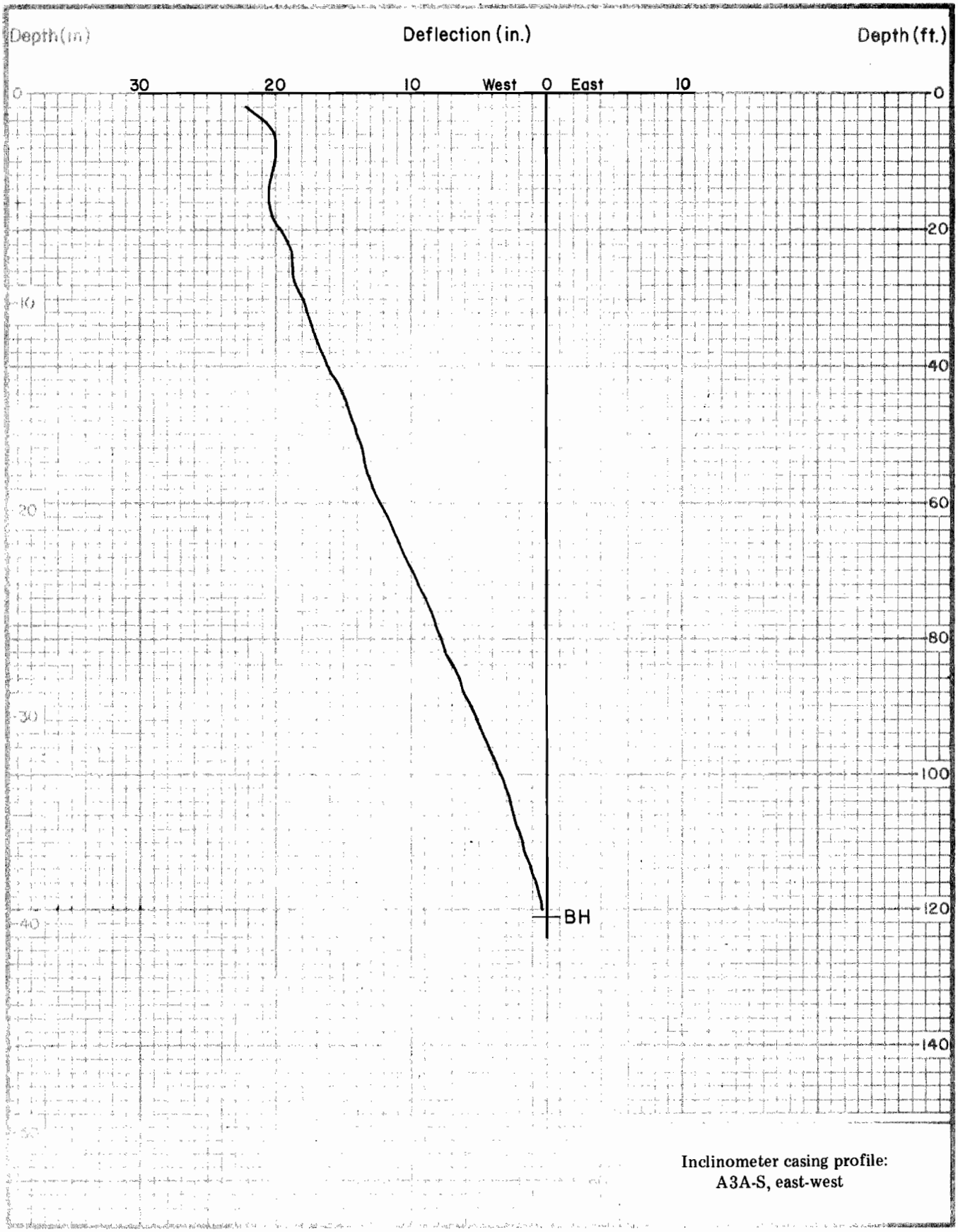


Inclinometer casing profile:
A2A, north-south

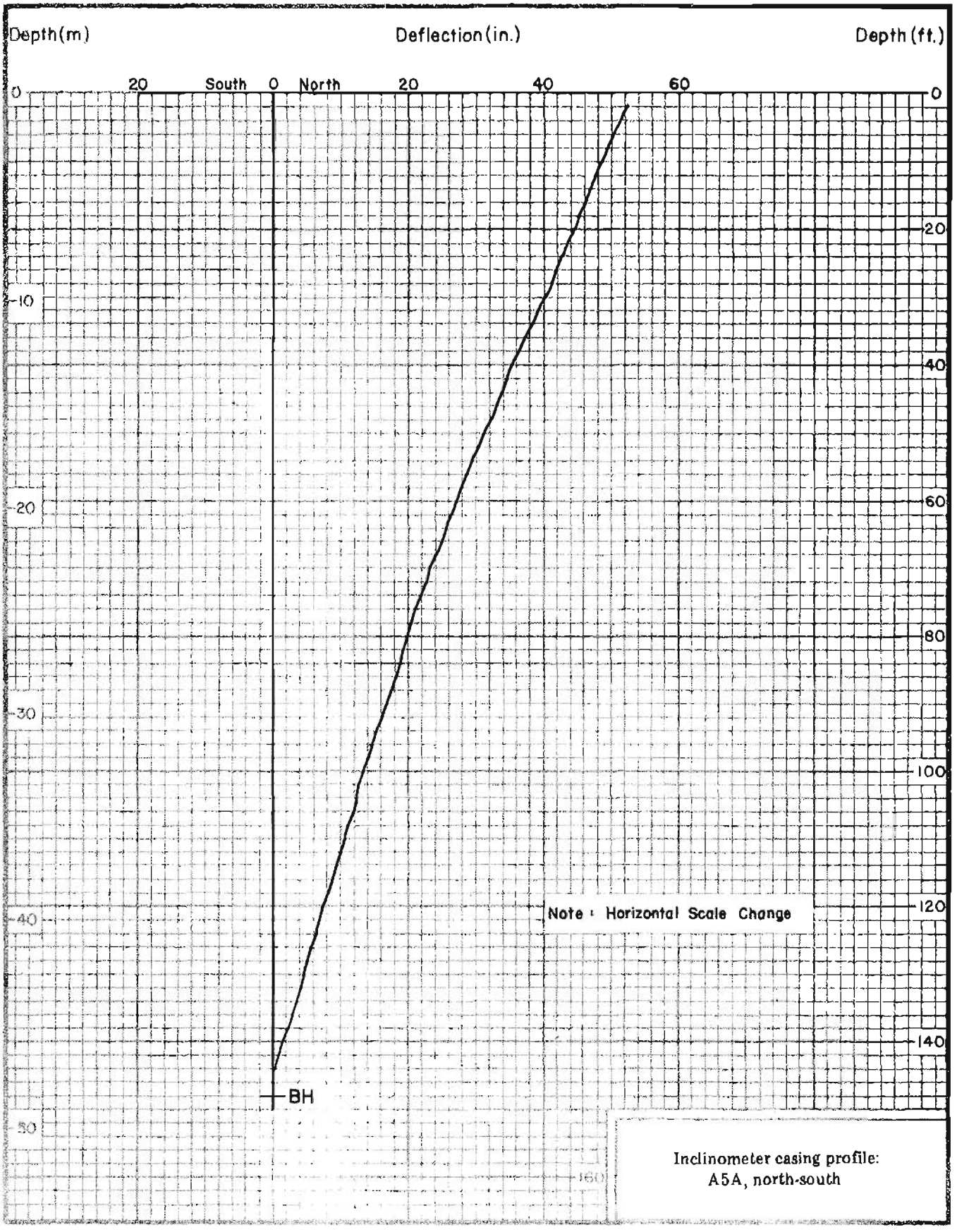
Inclinometer casing profile:
A2A, east-west



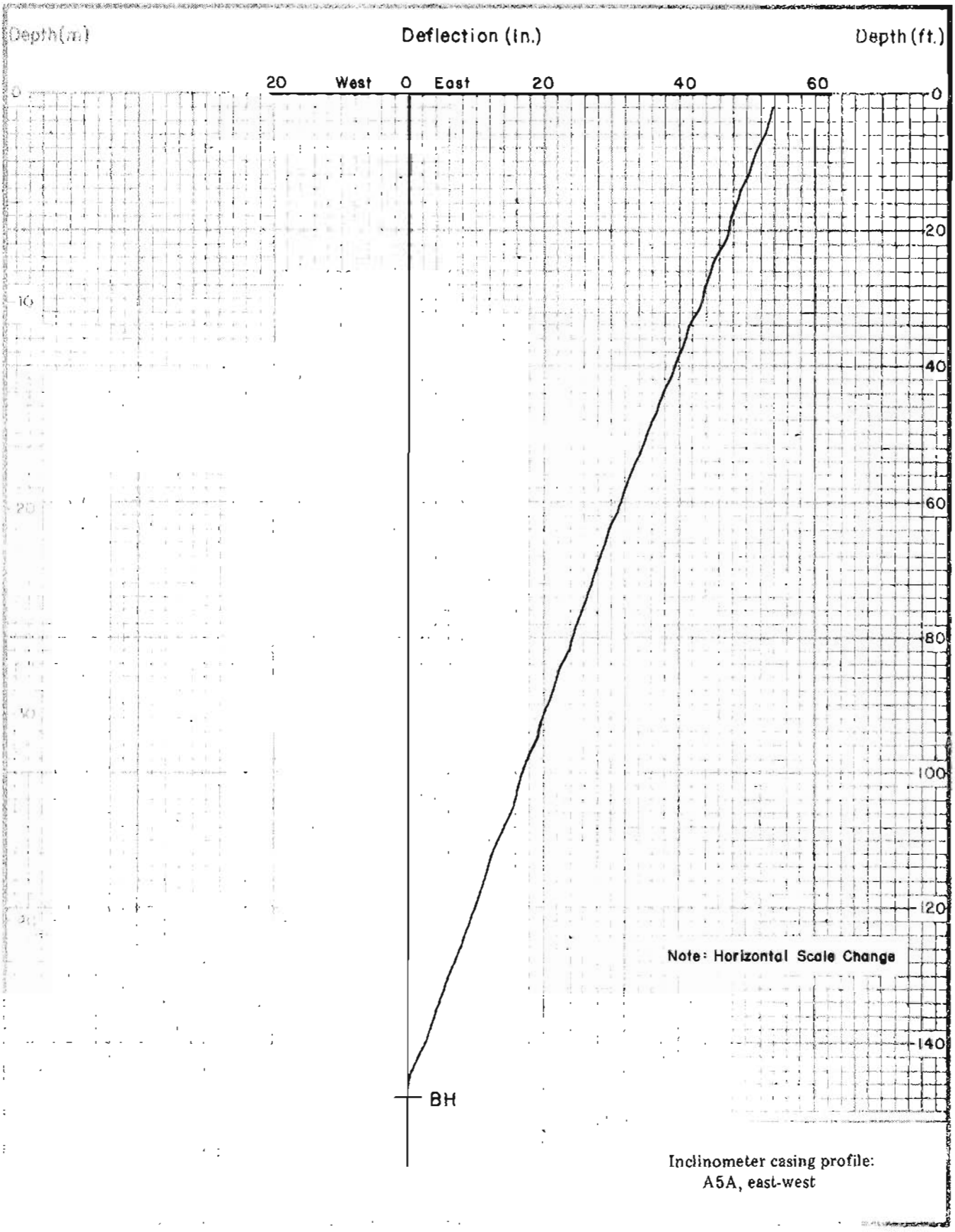
Inclinometer casing profile:
A3A-S, north-south



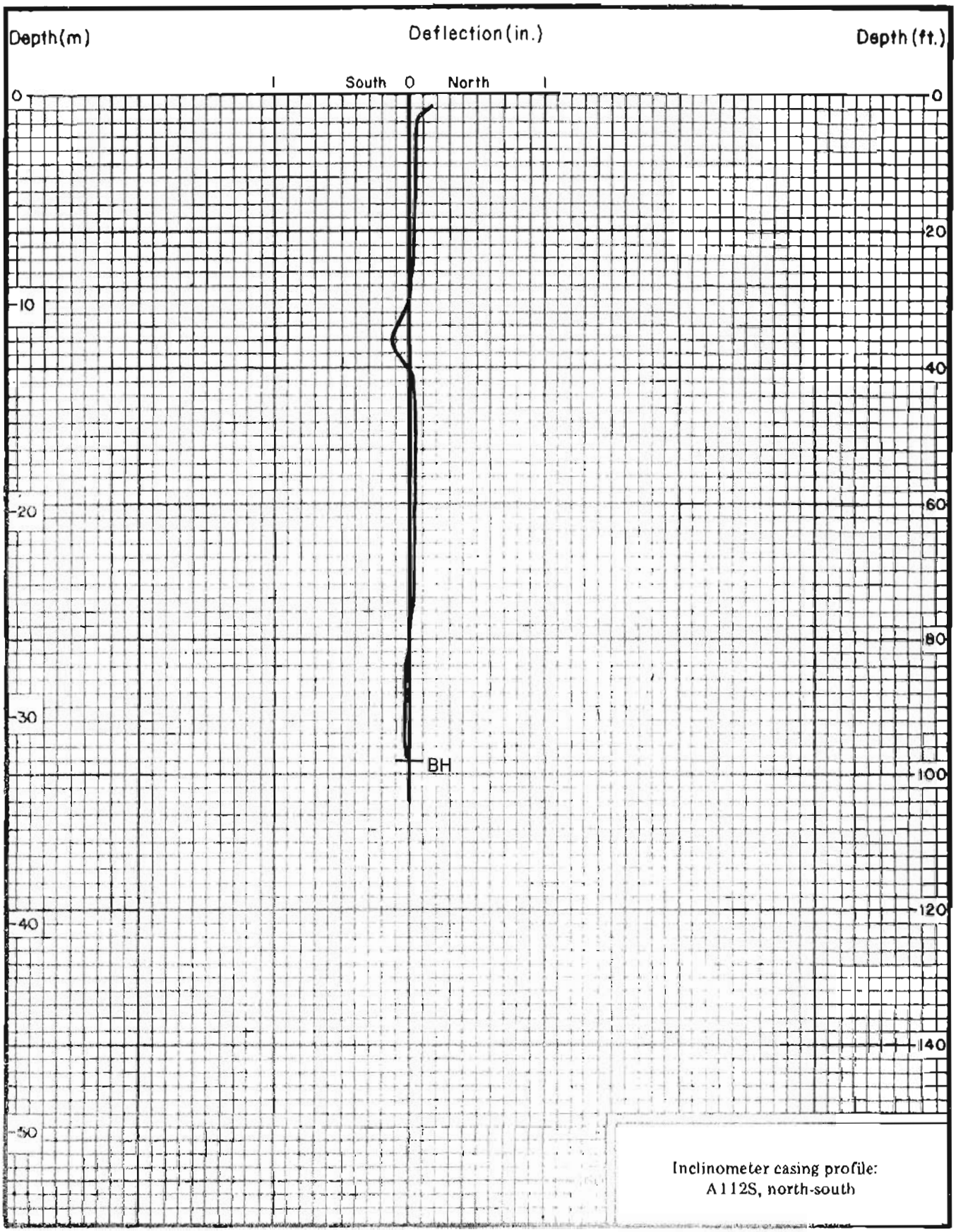
Inclinometer casing profile:
A3A-S, east-west



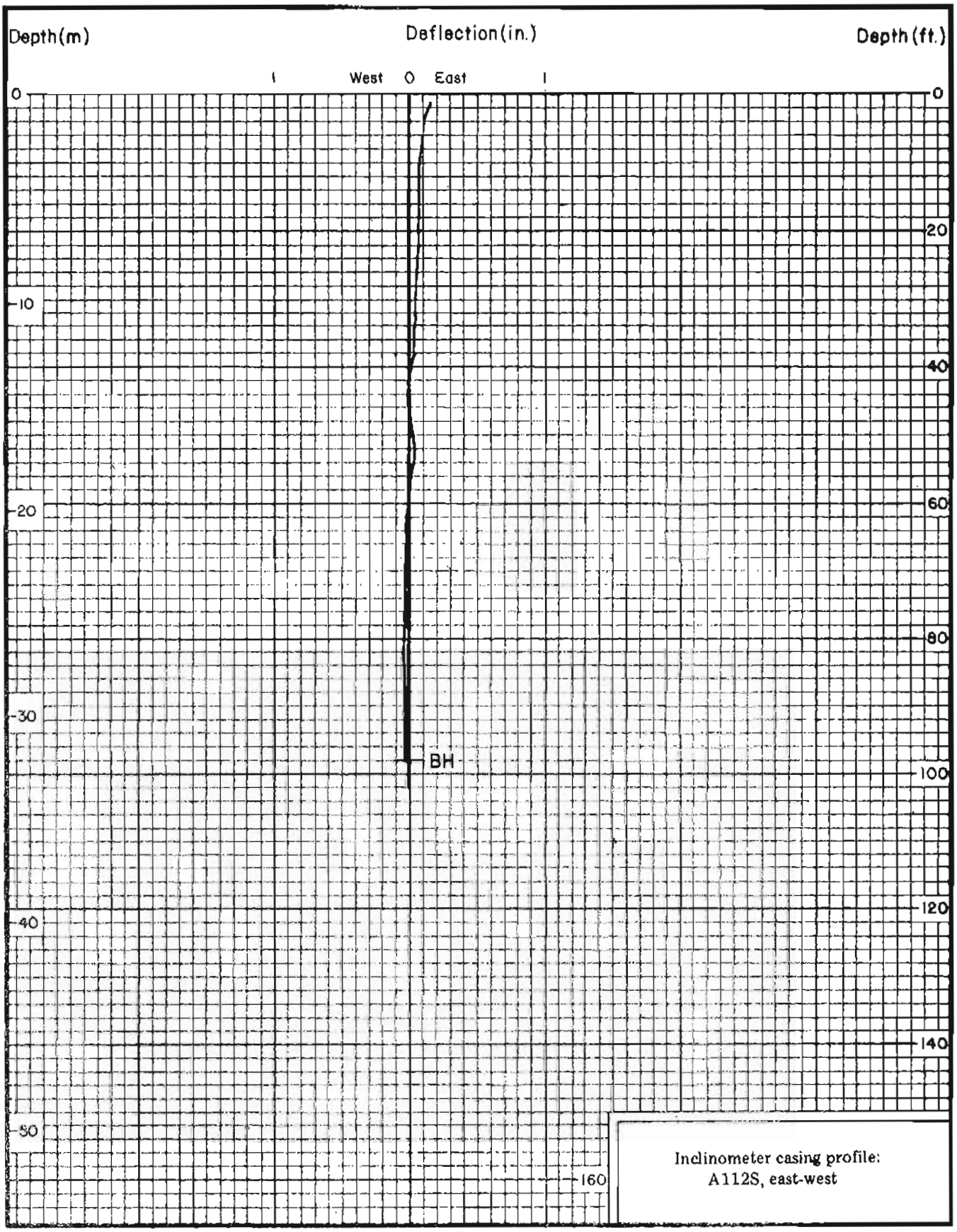
Inclinometer casing profile:
A5A, north-south



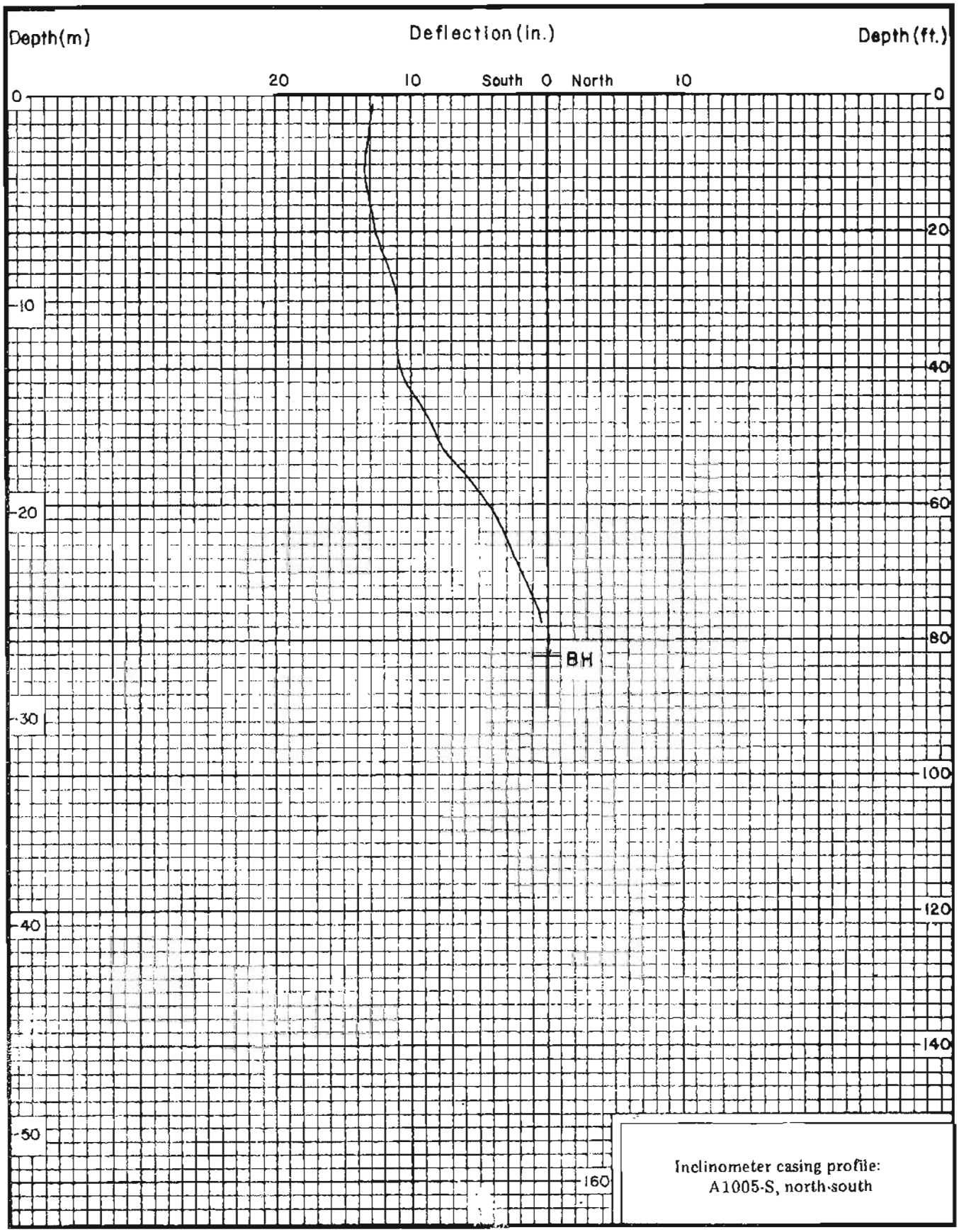
Inclinometer casing profile:
A5A, east-west



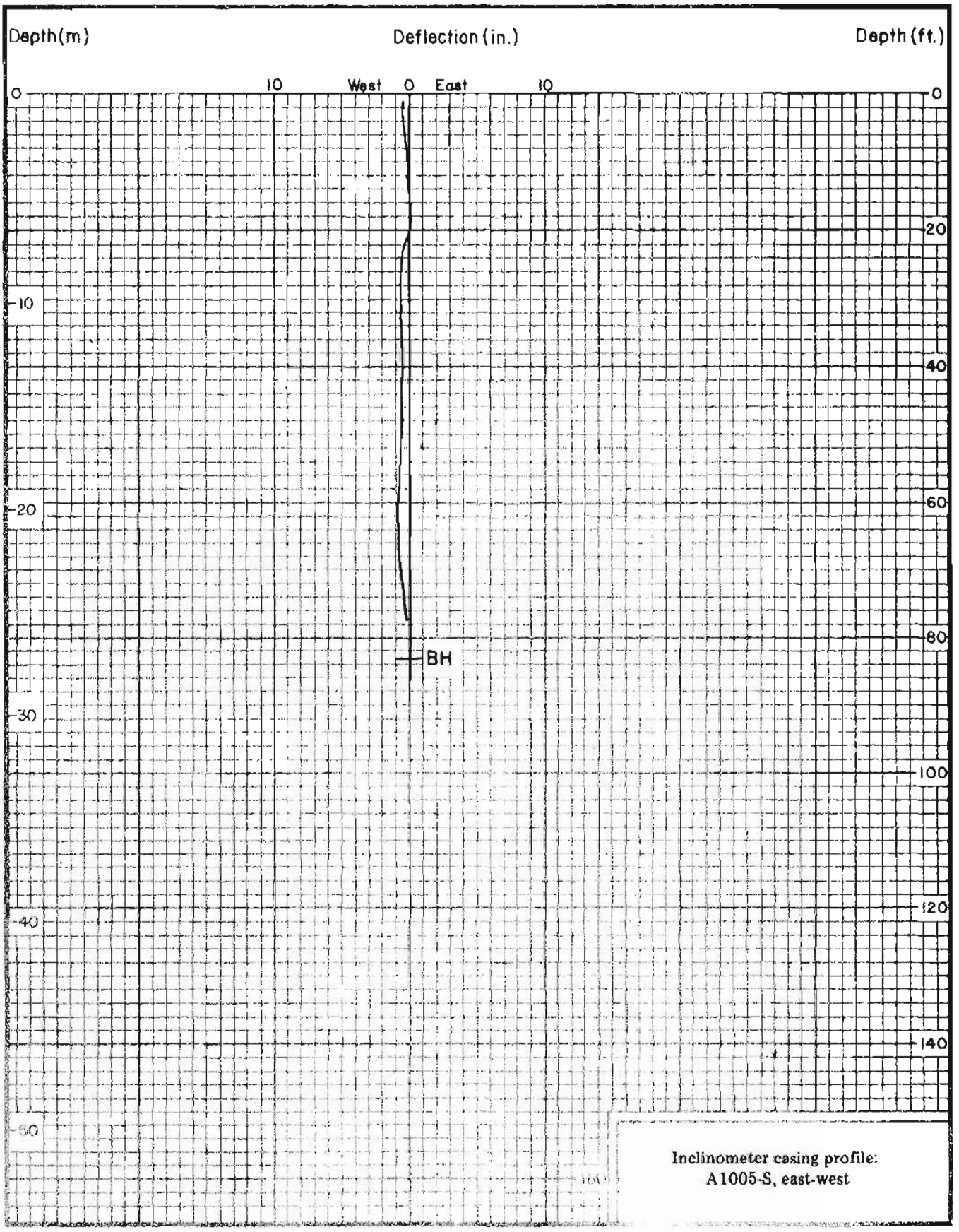
Inclinometer casing profile:
A112S, north-south



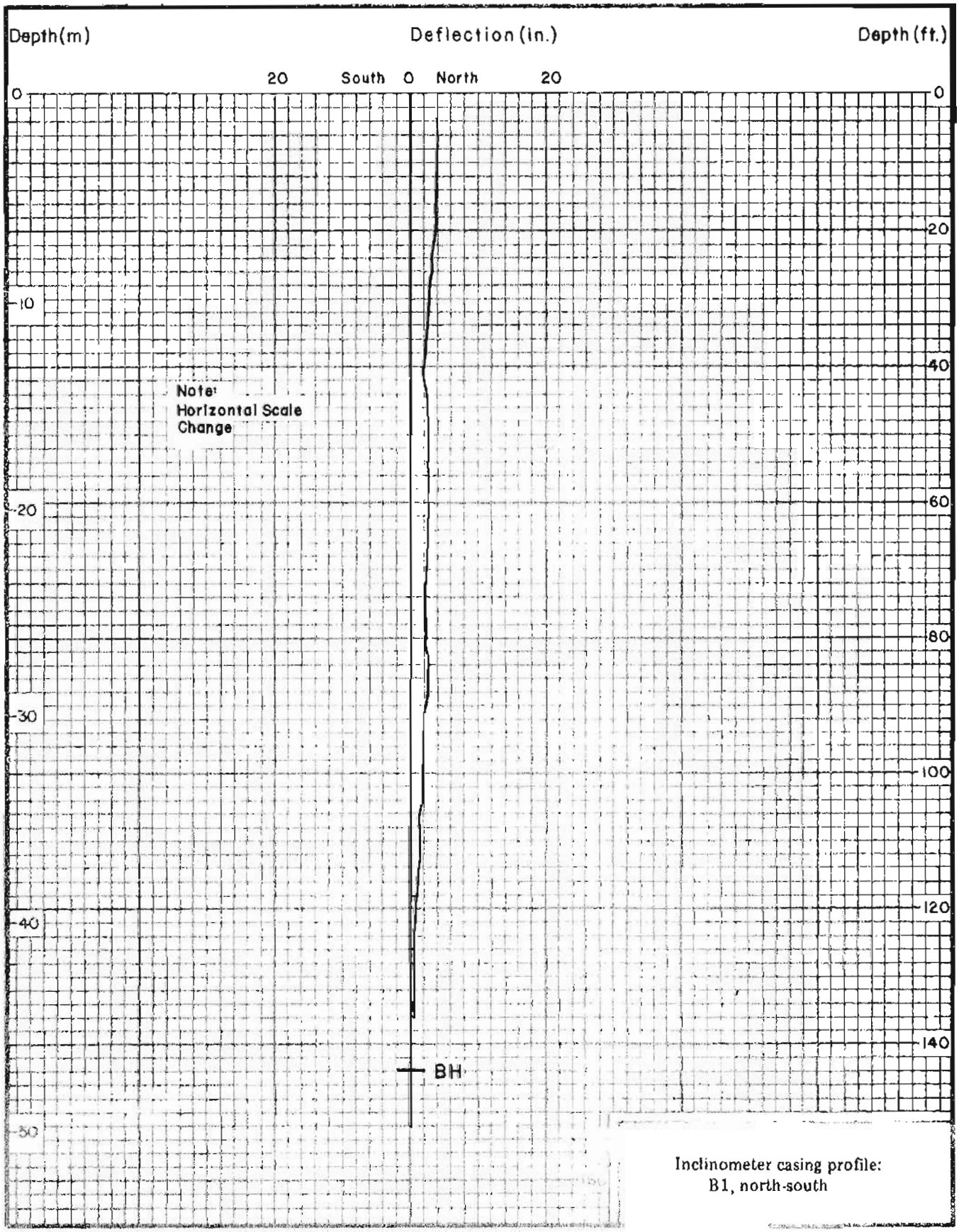
Inclinometer casing profile:
A112S, east-west



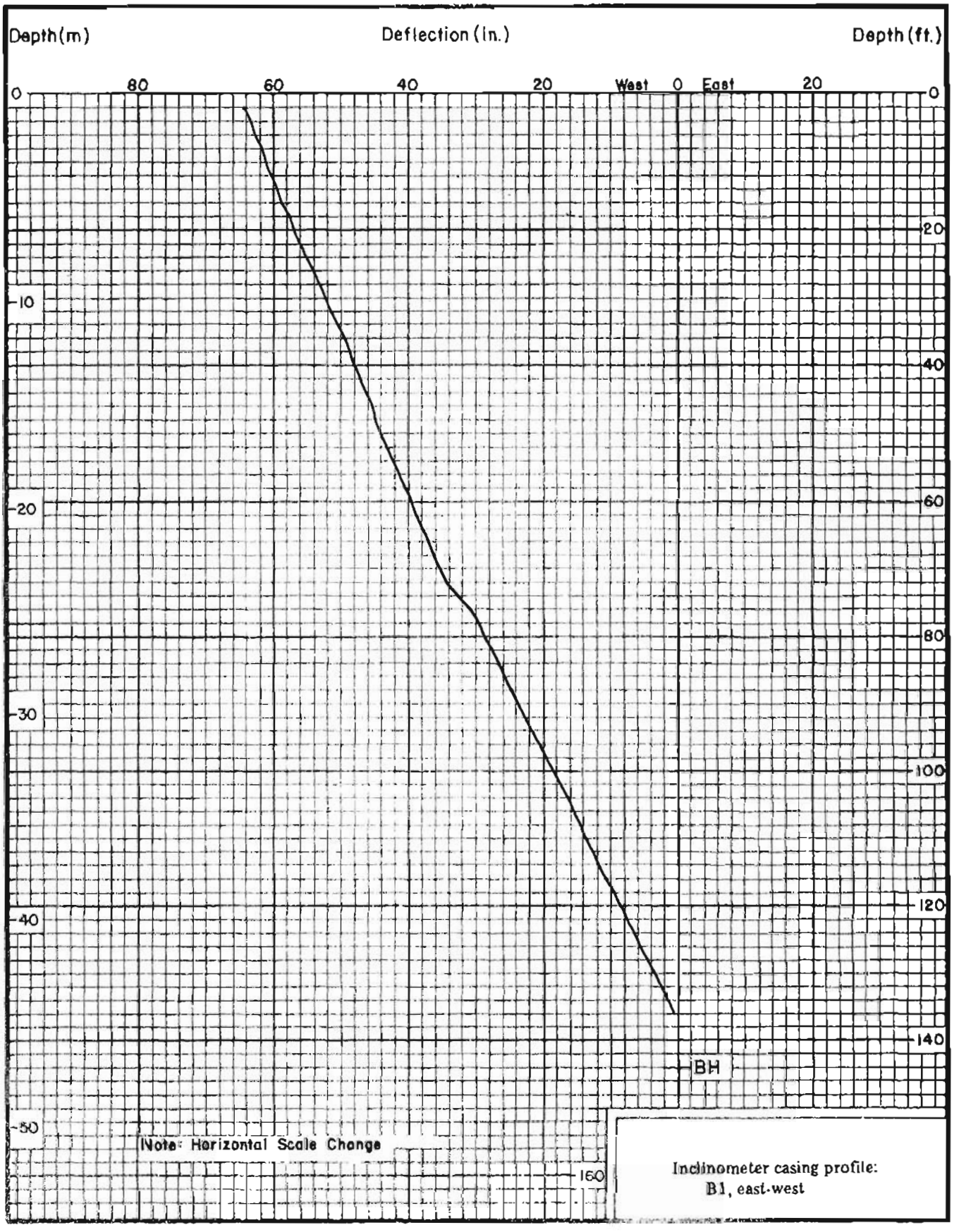
Inclinometer casing profile:
A1005-S, north-south



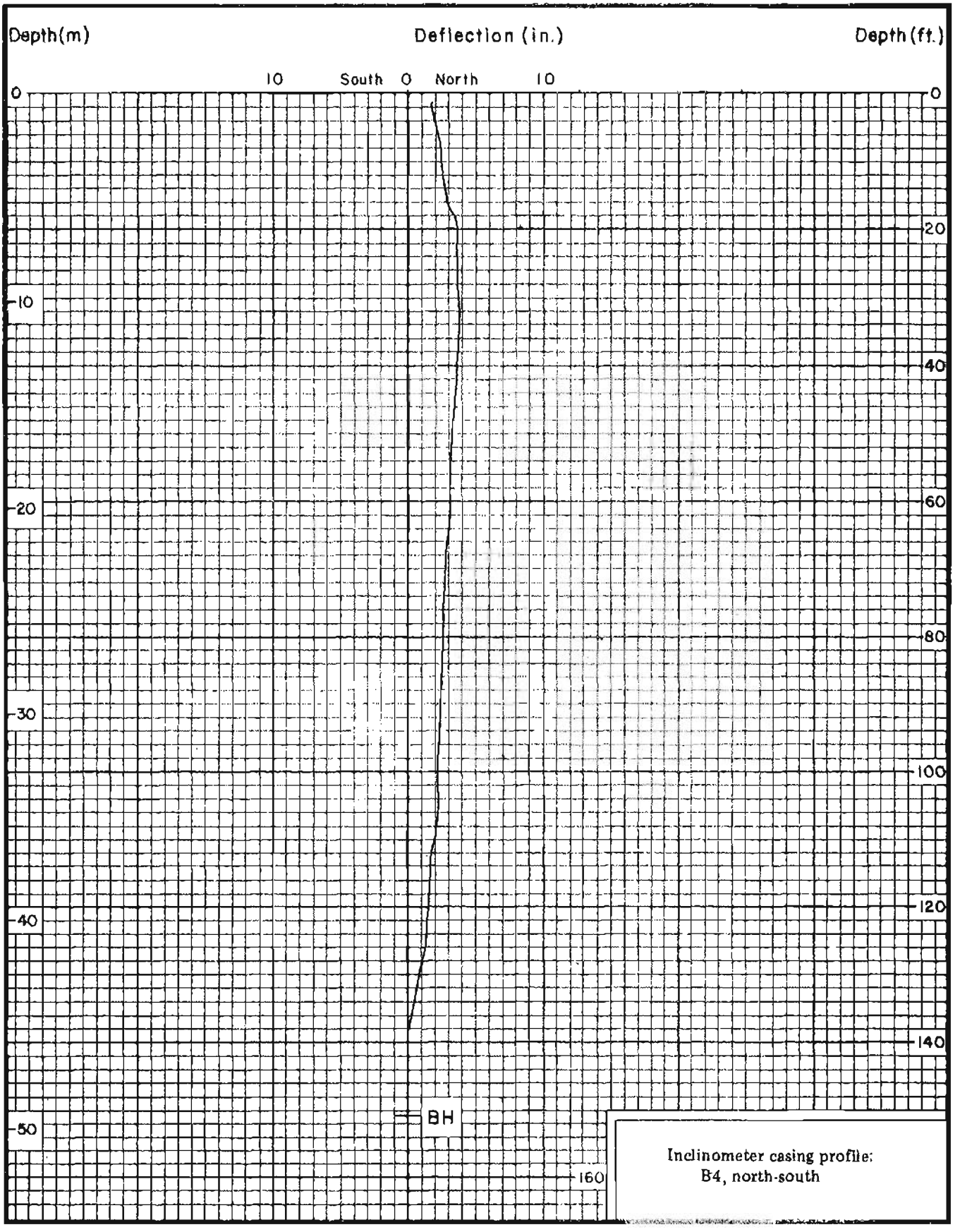
Inclinometer casing profile:
A1005-S, east-west



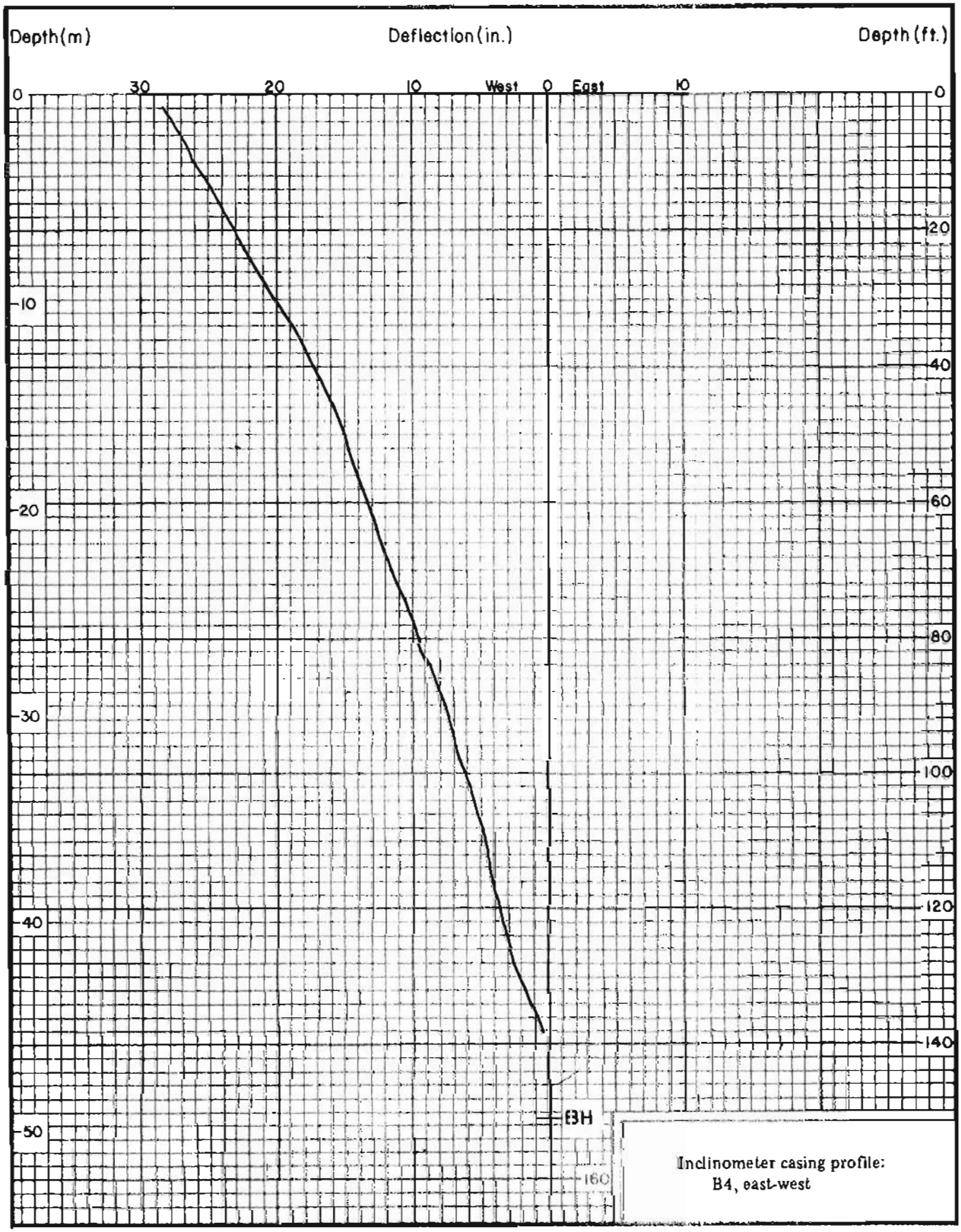
Inclinometer casing profile:
B1, north-south



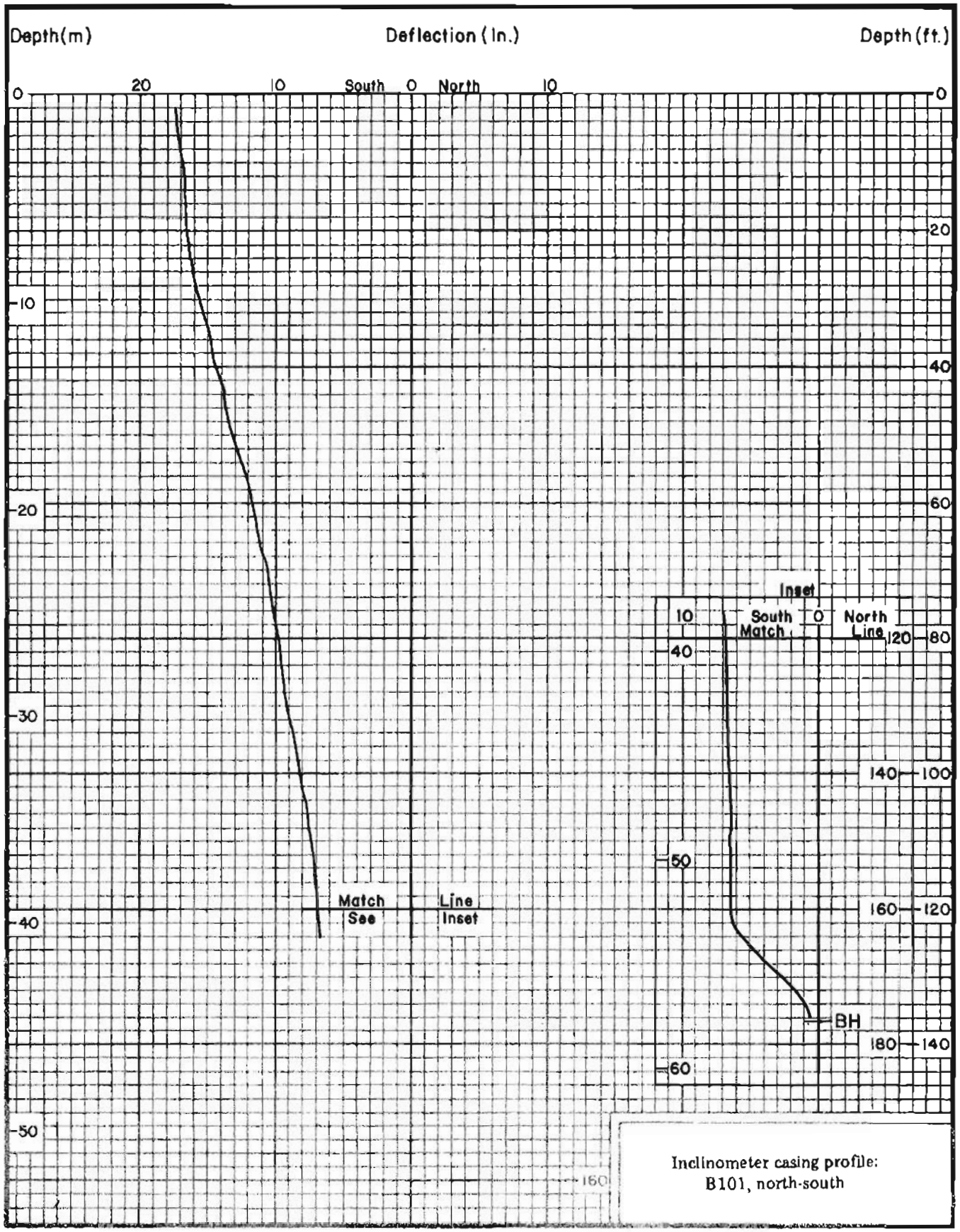
Inclinometer casing profile:
B1, east-west



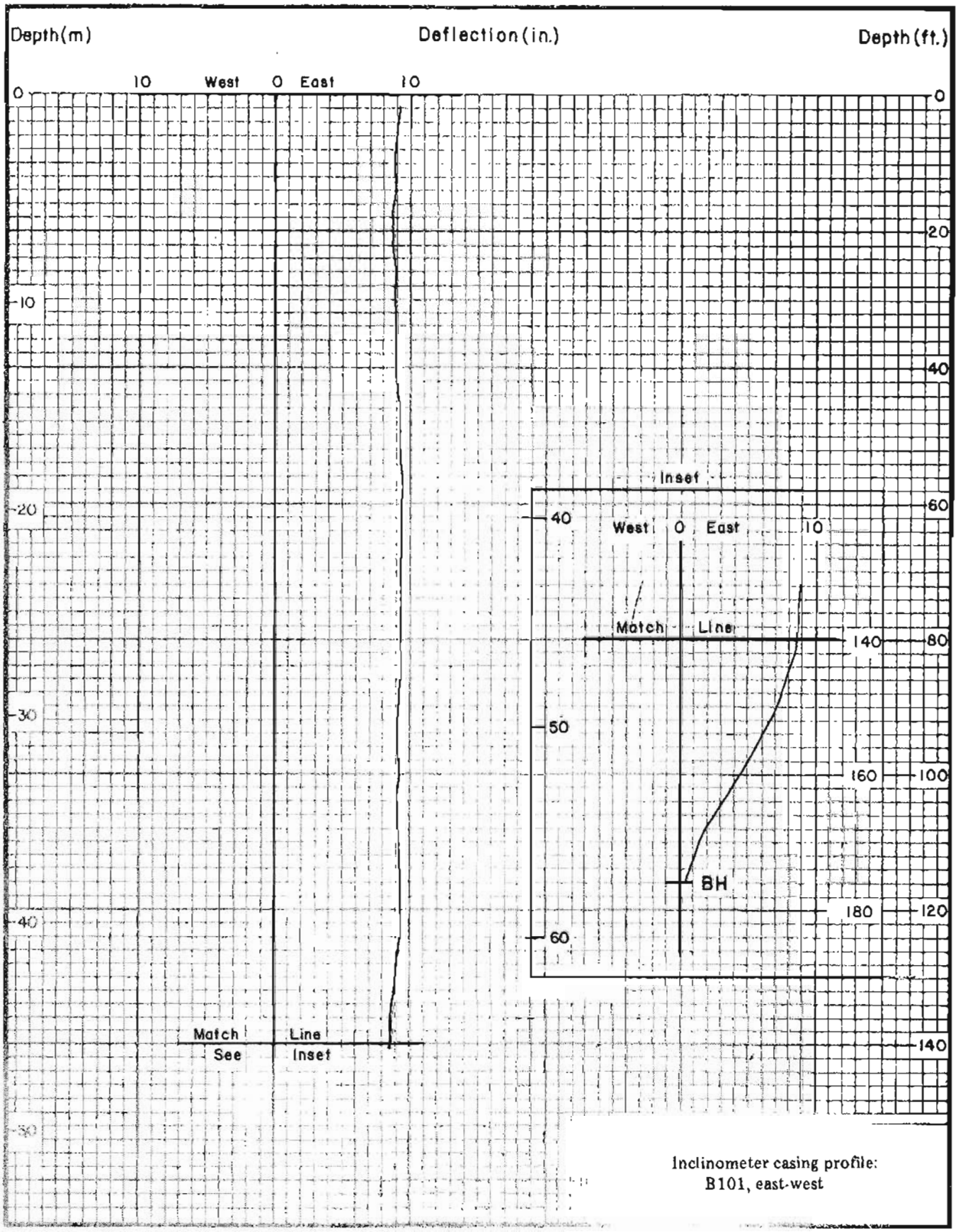
Inclinometer casing profile:
B4, north-south



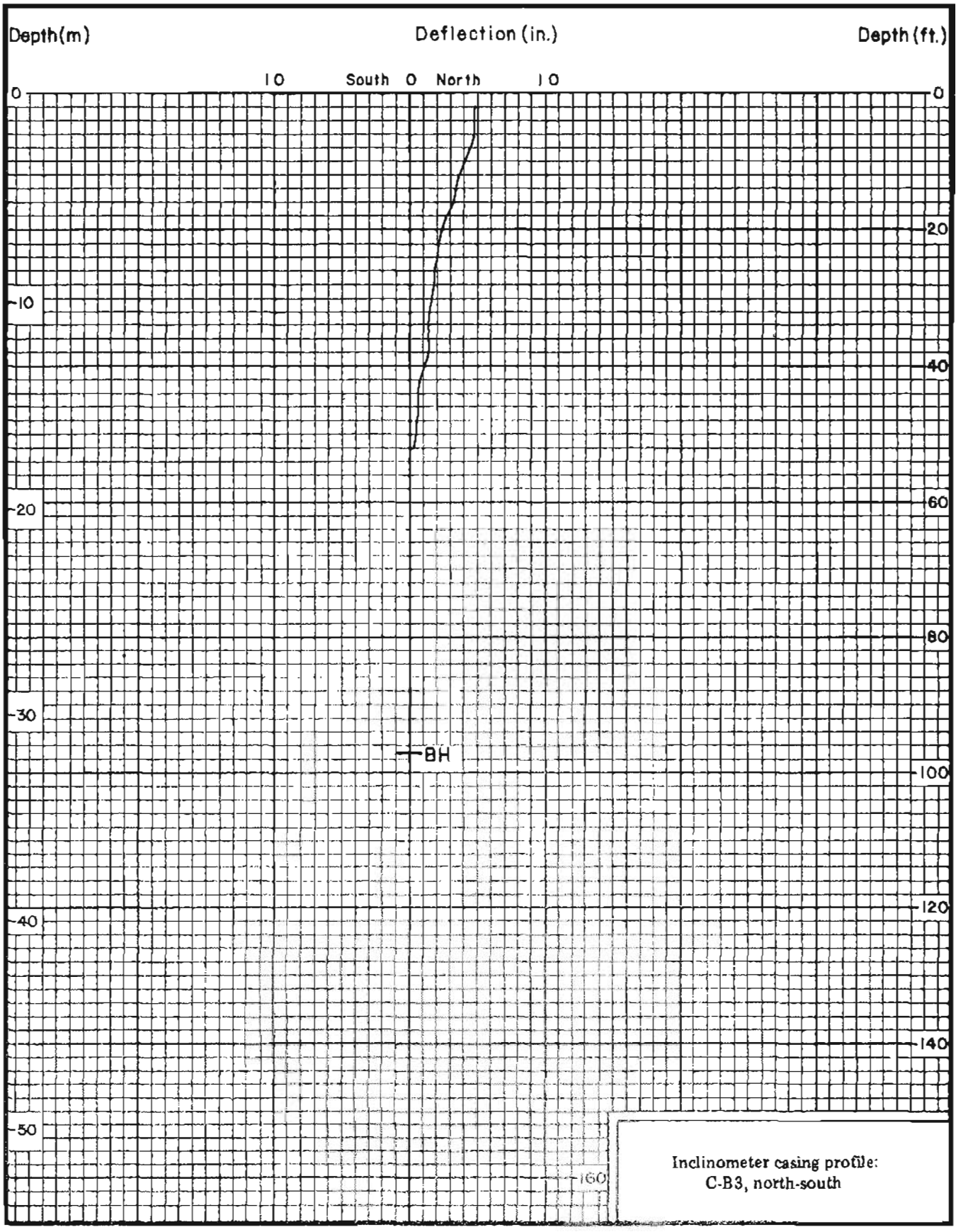
Inclinometer casing profile:
B4, east-west



Inclinometer casing profile:
B101, north-south

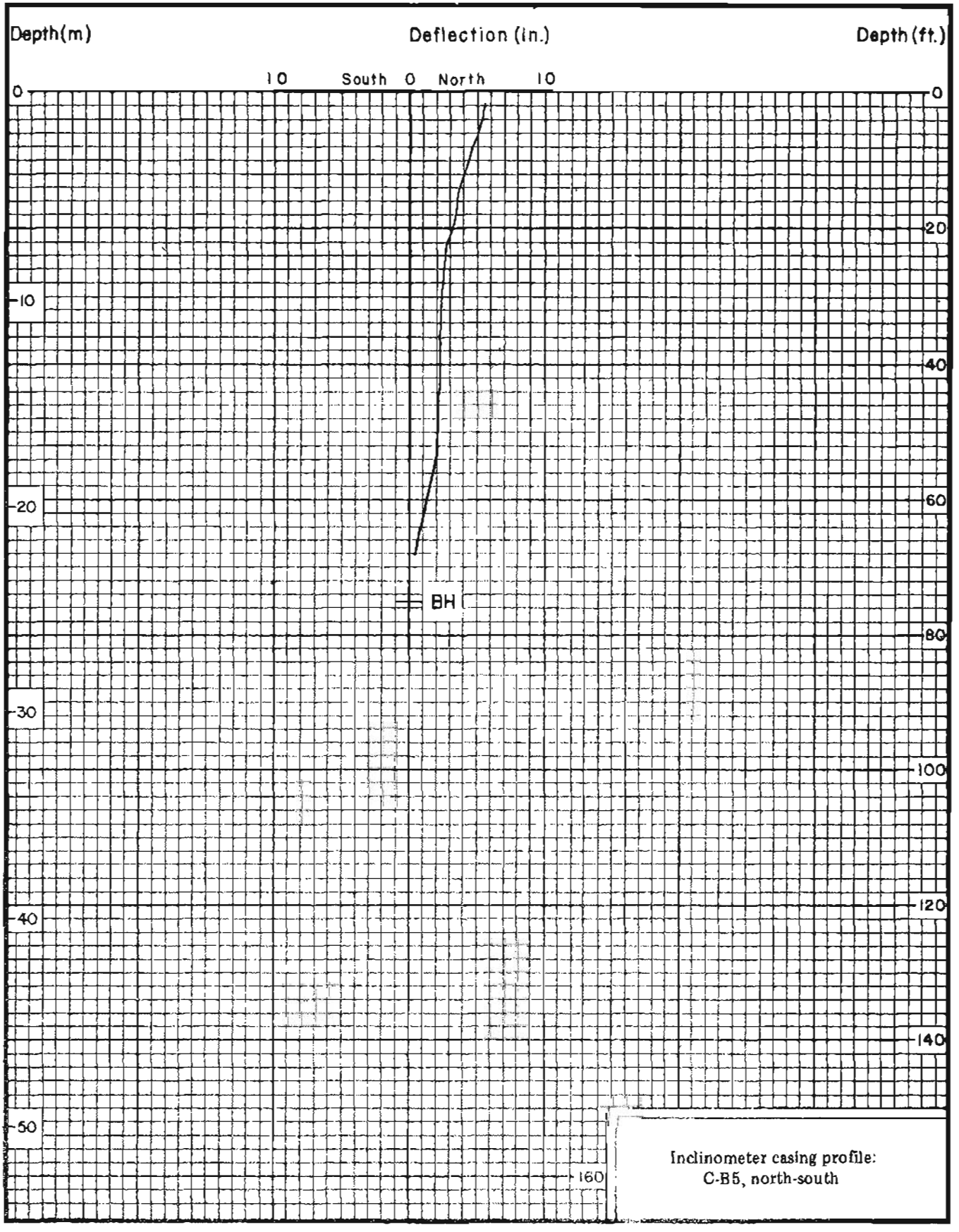


Inclinometer casing profile:
B101, east-west

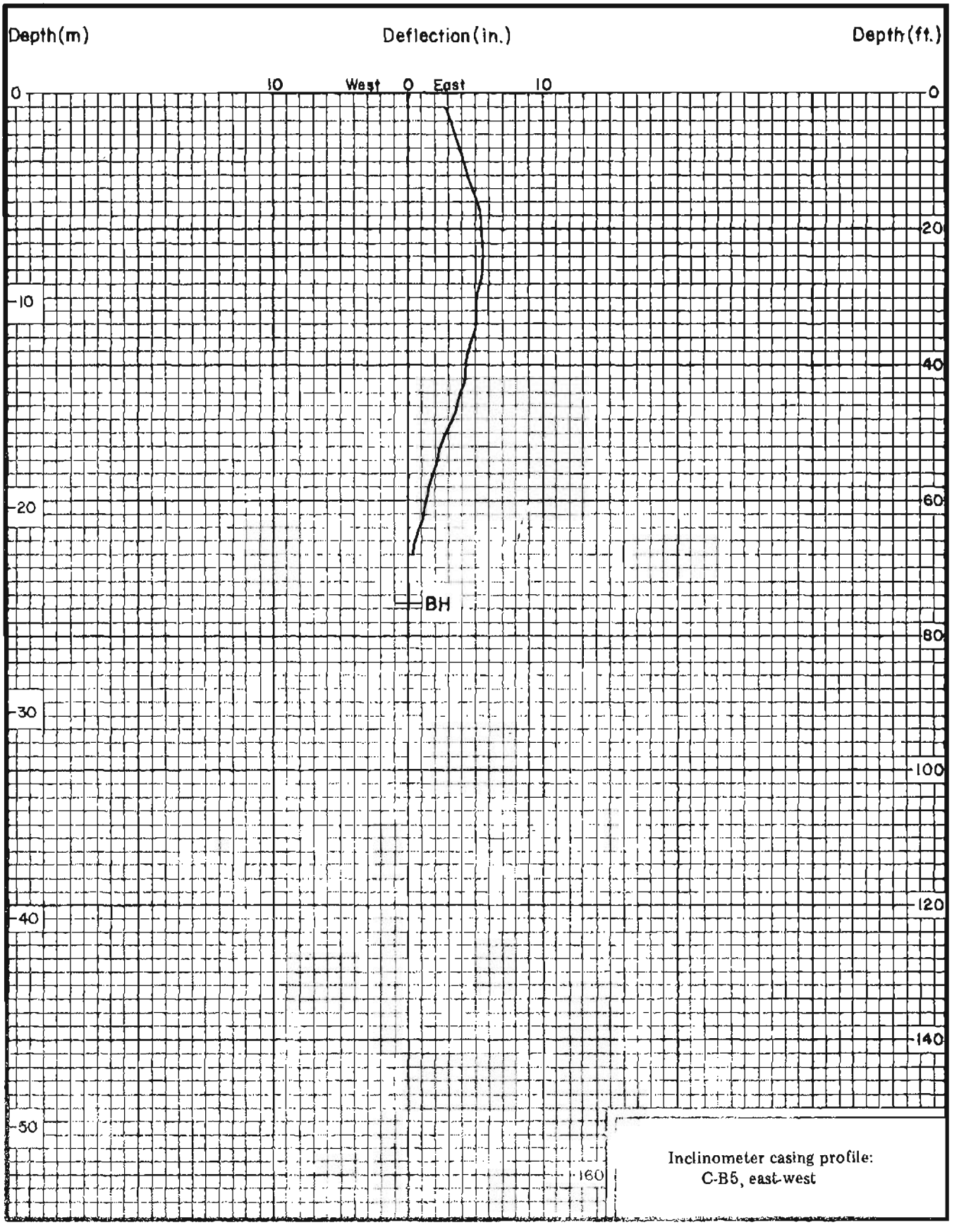


Inclinometer casing profile:
C-B3, north-south

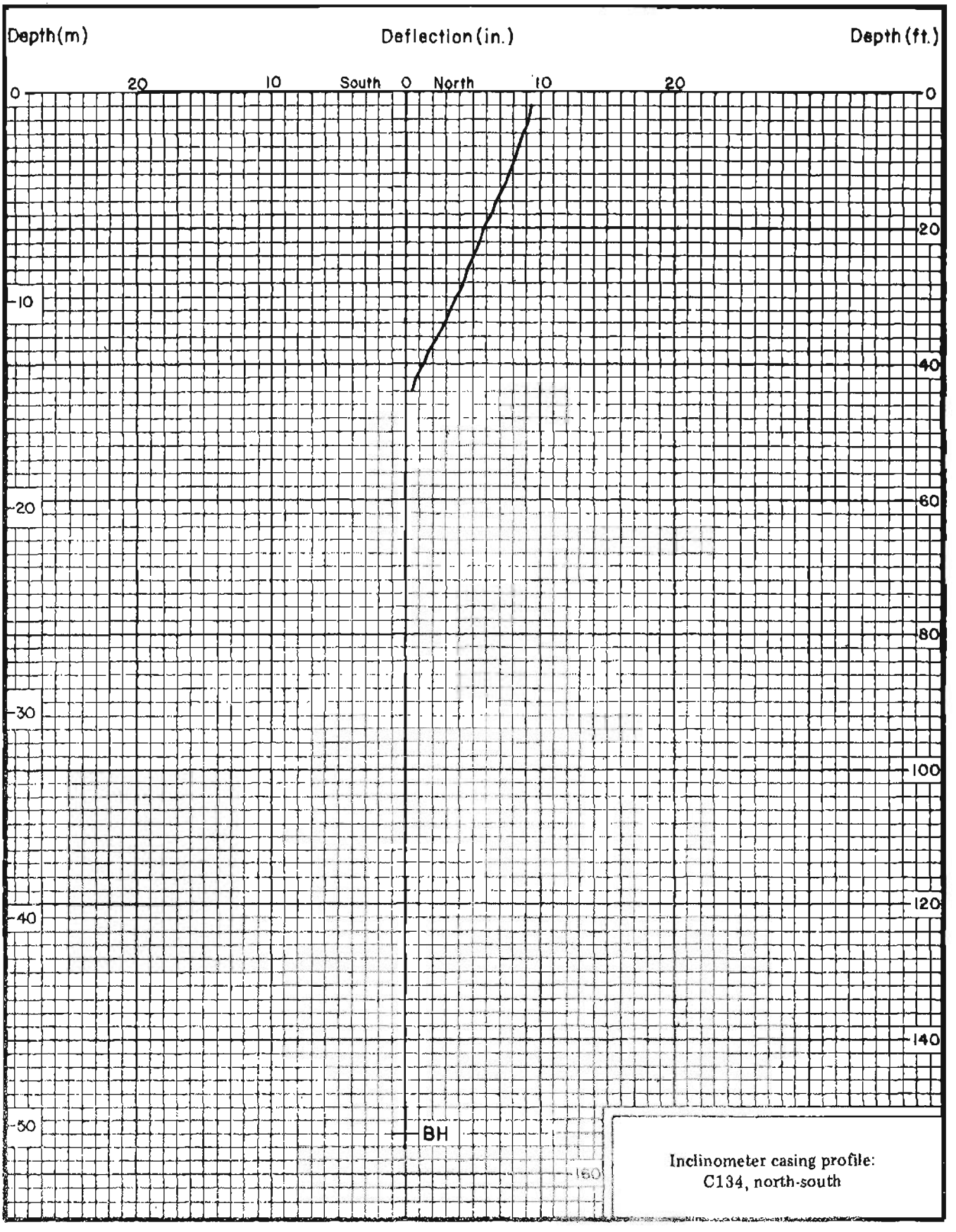
Inclinometer casing profile:
C-B3, east-west



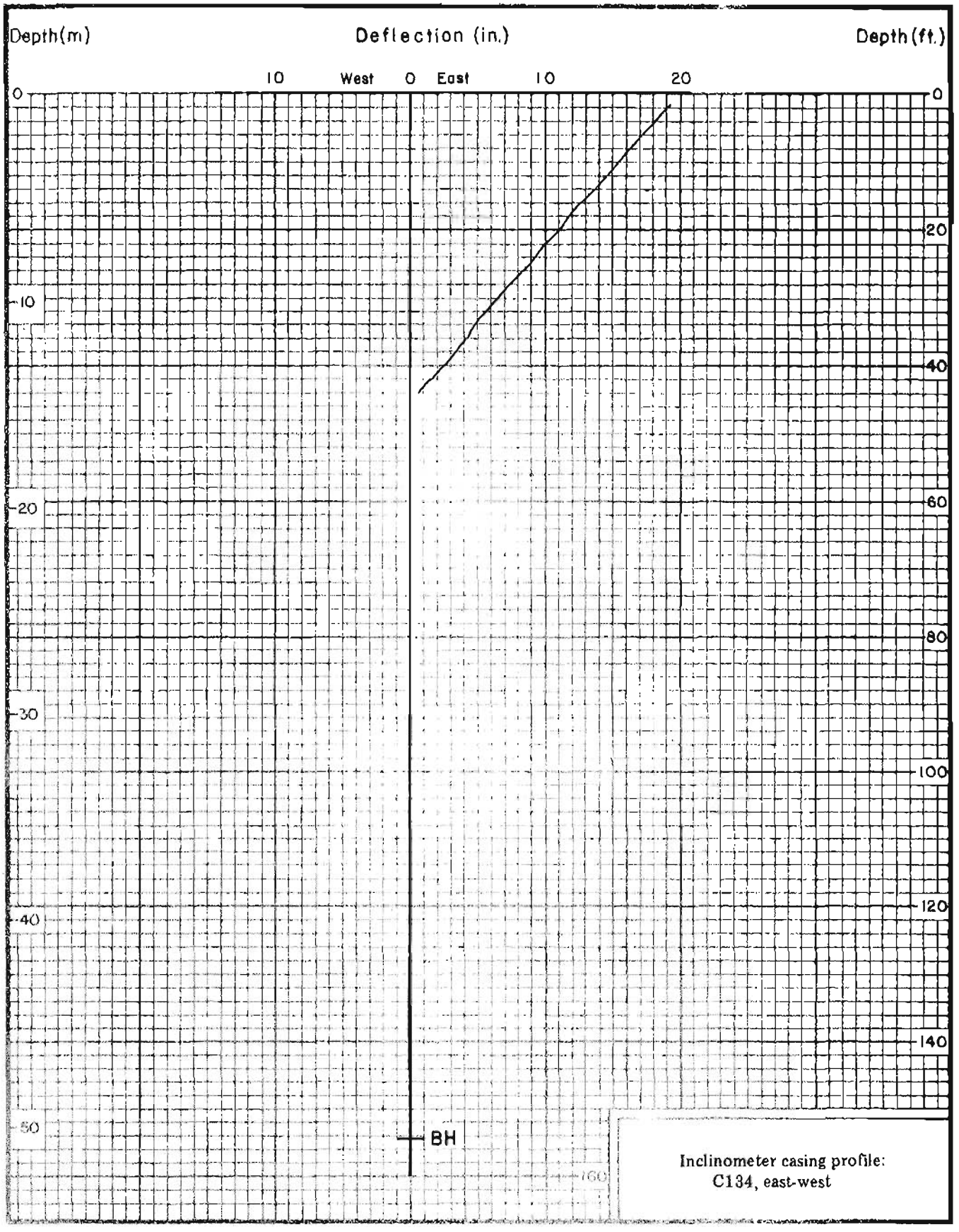
Inclinometer casing profile:
C-B5, north-south



Inclinometer casing profile:
C-B5, east-west



Inclinometer casing profile:
C134, north-south



Inclinometer casing profile:
C134, east-west

Appendix B

SLOPE-INDICATOR CASINGS

This appendix presents summary data for slope-indicator casings installed in Anchorage before the 1964 Prince William Sound Earthquake. Text figures 6-8 show casing locations; text table 1 reports their condition as of December 1980.

The columns denoted 'Initial' are the algebraic differences of the two sets of readings used in the initial calibration of the casings. Those denoted 'DEFL' are calculated cumulative deflections, in inches, from the initial 1964 calibrations. Positive values under DEFL are northward or eastward deflections; negative values indicate southward or westward movement since installation in 1964.

A1A	N/S			E/W		
Depth Feet	Initial 4/10/64	DEFL 8/24/64	DEFL 6/14/65	Initial 4/27/64	DEFL 8/24/64	DEFL 6/14/65
3.5	-43	+0.86	+1.26	82		
5	-39			83	+0.40	+0.89
6.5	-42			81		
8.5	-43			86		
10.0	-38			81		
11.5	-36			82		
14	-60	+0.78	+1.16	94	+0.40	+0.88
15.5	-66			95		
17	-68			94		
19	-69			86		
20.5	-69			88		
22	-69			84		
24.5	-54	+0.61	+0.97	88	+0.38	+0.81
26	-51			87		
27.5	-49			89		
29.5	-49			94		
31	-49			93		
32.5	-47			93		
35	-41	+0.53	+0.88	94	+0.30	+0.79
36.5	-40			92		
38	-42			93		
40	-44			90		
41.5	-45			86		
43	-40			79		
45.5	-40	+0.04	+0.74	85	+0.30	+0.74
47	-43			84		
48.5	-44			84		
50.5	-48			83		
52	-44			86		
53.5	-43			93		
56	-53	+0.32	+0.64	89	+0.30	+0.71
57.5	-52			89		
59	-54			90		
61	-45			78		
62.5	-44			77		
64	-50			75		
66.5	-51	+0.24	+0.54	86	+0.28	+0.66
68	-50			85		
69.5	-48			84		
71.5	-46			78		
73	-44			76		
74.5	-42	+0.18	+0.45	76	+0.26	+0.61
77	-48	+0.18	+0.44	82	+0.26	+0.60
78.5	-47			84		
80	-41			82		
82	-41			80		
83.5	-41			87		

A1A	N/S			E/W		
Depth Feet	Initial 4/10/64	DEFL 8/24/64	DEFL 6/14/65	Initial 4/27/64	DEFL 8/24/64	DEFL 6/14/65
85	-44			84		
87.5	-40	+0.16	+0.40	88	+0.25	+0.56
89	-40			86		
90.5	-38			85		
92.5	-41			86		
94	-41			82		
95.5	-42			67		
98	-53	+0.04	+0.23	73	+0.12	+0.40
99.5	-53			73		
101	-52			73		
103	-46			71		
104.5	-48			68		
106	-50			66		
108.5	-48	-0.05	+0.11	67	+0.10	+0.31
110	-48			63		
111.5	-52			62		
113.5	-54			67		
115	-51			68		
116.5	-50			69		
119	-48	-0.11	+0.04	82	+0.04	+0.28
120.5	-50			79		
122	-48			81		
124	-41			77		
125.5	-40			77		
127	-40			73		
129.5	-45	-0.13	-0.03	73	+0.03	+0.18
131	-46			71		
132.5	-56			69		
134.5	-57			70		
136	-56			67		
137.5	-56			64		
140	-65	-0.09	-0.05	69	+0.03	+0.08
141.5	-59			77		
143	-49			77		
145	-45			68		
146.5	-47			64		
148	-48			73		
150.5	-40	-0.07	-0.05	65	+-.01	+0.02
152	-47			57		

A2A N/S						
Depth Feet	Initial 4/11/64	DEFL 8/24/64	DEFL 1965	DEFL 1977	DEFL 1978	DEFL 1979
3	+21	-0.11	+0.04	+0.01	+0.50	(0.55)
4	+22					+0.65
6	+16					
8	+10					
10	+ 9	-0.10	+0.04	-0.04	+0.41	+0.52
12	+ 1					
14	- 6					
16	- 7					
18	-11					
20	-11	+0.03	+0.16	-0.98	-0.80	-0.74
22	- 9					
24	-22					
26	-24					
28	-25	+0.10	+0.23			
30	-52			-1.78	-1.58	-1.55
32	-49					
34	-48					
36	-47					
38	-45	+0.20	+0.29			
40	-18			-2.73	-2.54	-2.54
42	-20					
44	-14					
46	- 8					
48	- 7					
50	- 1			-1.97	-1.69	-1.68
52	+10	+0.14	+0.20			
54	+ 5					
56	- 4					
58	- 3					
60	+15	-0.12	-0.06	-1.82	-1.52	-1.76
62	+22					
64	+34					
66	+16					
68	+10	-0.16	-0.16			
70	+ 5			-1.45	-1.13	-1.34
72	+ 2					
74	+ 2	+0.02	+0.04			
76	+ 3					
78	+ 2					
80	+ 1	+0.06	+0.11	-1.70	-1.49	-1.63
82	+22					
84	+25					
86	+21	-0.02	-0.01			
88	+20					
90	+22			-1.03	-0.88	-1.01
92	+26					
94	+25	+0.06	+0.10			

A2A N/S						
Depth Feet	Initial 4/11/64	DEFL 8/24/64	DEFL 1965	DEFL 1977	DEFL 1978	DEFL 1979
96	+31					
98	+34					
100	+35			-0.80	-0.70	-0.83
102	+31					
104	+29	+0.11	+0.12			
106	+32					
108	+26					
110	+38	0	+0.09	-0.46	-0.40	-0.53
112	+41					
114	+39					
116	+43					
118	+44					
120	+43		-0.25	-0.22		-0.32
122	+41	-0.02	+0.01			
124	+39					
126	+38					
128	+52	-0.08	-0.06			
130	+59			-0.19	-0.18	-0.29
132	+50					
134	+46					
136	+50					
138	+46					
140	+46					-0.07
142	+49					
144	+54					
146	+54					-0.06
148						
150						

A2A E/W						
Depth Feet	Initial 4/29/64	DEFL 8/24/64	DEFL 6/10/65	DEFL 1977	DEFL 1978	DEFL 1979
3	-23	-0.21	-0.19	-3.47	-3.14	(-3.95)
4	-25					-3.51
6	-29					
8	-30					
10	-30			-1.94	-1.60	-2.41
12	-30					
14	-31	-0.35	-0.35	-1.59	-1.23	-2.12
16	-31					
18	-36					
20	-36			-1.58	-1.24	-2.10
22	-36					
24	-47	-0.44	-0.35	-1.73	-1.39	-2.25
26	-44					
28	-44					
30	-42			-2.04	-1.70	-2.56
32	-38					
34	-37	-0.43	-0.35	-2.14	-1.80	-2.65
36	-36					
38	-37					
40	-30			-1.91	-1.58	-2.44
42	-31					
44	-25	-0.41	-0.30	-1.80	-1.47	-2.33
46	-18					
48	-19					
50	- 8			-1.54	-1.19	-2.04
52	- 4					
54	- 5					
56	- 7	-0.38	-0.26	-1.13	-0.79	-1.59
58	-15					
60	-29			-1.60	-0.69	-1.50
62	-43	-36				
64	-63					
66	-61	-0.32	-0.25	1.72	-1.33	-2.15
68	-44					
70	-16			-2.25	-1.88	-2.66
72	- 2					
74	- 5					
76	-14	-0.31	-0.25	-1.61	-1.24	-2.08
78	-11					
80	-13					
82	-31					-1.52
84	-38					
86	-37	-0.22	-0.15	-0.80	-1.10	-1.81
88	-36					
90	-37			-1.10	-1.39	-2.06
92	-32					
94	-33					

A2A E/W

Depth Feet	Initial 4/29/64	DEFL 8/24/64	DEFL 6/10/65	DEFL 1977	DEFL 1978	DEFL 1979
96	-29					
98	-27	-0.20	-0.05	-1.11	-1.38	-2.04
100	-23			-1.04	-1.31	-1.97
102	-27					
104	-24					
106	-25					
108	-36	-0.22	-0.07	-0.85	-1.10	-1.76
110	-34			-0.91	-1.18	-1.83
112	-22					
114	-19					
116	-16					
118	-13	-0.13	-0.04	-0.88	-1.12	-1.78
120	-10			-0.77	-0.96	-1.63
122	-10					
124	- 2					
126	- 2					
128	- 3	+0.01	+0.01	-0.23	-0.25	-1.10
130	- 3					-1.01
132	0					
134	+ 7		-0.01	-0.11	-0.12	-0.88
136	+ 8					
138	+15					
140	+26					-0.49
142	+24					
144	+25					-0.14
146						
148						
150						

A3A N/S

Depth Feet	Initial 4/15/64	DEFL 8/24/64	DEFL 6/13/65	DEFL 2/23/76	Initial 12/5/77	DEFL 8/22/78	DEFL 1979
2					+305	-0.07	-0.03
4					+174		
6					+ 72		
8					+ 80		
10					+ 64	-0.02	+0.05
12					+ 32		
14					+ 24		
16					+106	-0.02	+0.08
18					+190		
20					+196	-0.05	+0.36
22					+195		
24					+172		
26					+ 91	-0.05	+0.32
28					- 47		
30					- 37	-0.01	-0.02
32					- 38		
34					- 47		
36					- 39	-0.01	-0.02
	Surface	1964/65			DEFL		
38	-33	-1.78	-2.06	-1.28	-1.24	-1.06	-1.09
40	-35						
42	-18	-1.78	-2.08	-1.48	-1.42	-1.27	-1.30
44	-18						
46	- 1	-1.45	-1.72	-1.69	-1.64	-1.46	-1.49
48	+ 4						
50	+10						
52	+ 5						
54	+ 1						
56	- 5						
58	-10	-1.18	-1.40	-0.66	-0.56	-0.42	-0.38
60	-12						
62	-16						
64	-17						
66	-16						
68	-29	-0.83	-0.96	-0.22	-0.16	-0.04	-0.04
70	-28	-0.71	-0.82	-0.19	-0.14		

A3A N/S							
Depth Feet	Initial 4/15/64	DEFL 8/24/64	DEFL 6/13/65	DEFL 2/23/76	DEFL 12/5/77	DEFL 8/22/78	DEFL 1979
88	-27	-0.53	-0.58	-0.03	+0.01	+0.06	+0.05
90	-23						
92	-23						
94	-24						
96	-27						
98	-27						
100	-29	-0.28	-0.34	-0.05	0	-0.02	+0.02
102	-29						
104	-29						
106	-29						
108	-31						
110	-28	-0.22	-0.26	-0.08	-0.05	-0.08	0
112	-30	-0.20	-0.22	-0.06	-0.07	-0.07	0
114	-31						
116	-29						
118	-29						
120	-34	-0.13	-0.12	+0.02	+0.03	+0.02	+0.07
122	-33						
124	-34						
126	-42						
128	-31	-0.08	-0.11				
130	-30						
132	-28						
134	-44						
136	-45						
138	(-43)						

A3A E/W

Depth Feet	Initial 5/1/64	DEFL 8/24/64	DEFL 6/13/65	DEFL 2/23/76	Initial 12/5/77	DEFL 8/22/78	DEFL 1979
2					-239	-0.20	+0.16
4					-135		
6					- 4		
8					+ 30		
10					+ 35	-0.17	+0.14
12					+ 20		
14					- 11		
16					- 61		
18					- 72		
20					- 74	-0.05	+0.06
22					- 59		
24					- 26		
26					- 38		
28					- 74		
30					- 76	+0.01	0
32					- 64		
34					- 59		
36					- 62		
		Surface 1964/1965			DEFL		
38	-90	+0.72	+0.67	+2.71	+2.81	+2.70	+2.62
40	-90						
42	-76						
44	-79	+0.55	+0.50	+2.60	+2.71	+2.63	+2.53
46	-78						
48	-79						
50	-78						
52	-76						
54	-74						
56	-75	+0.44	+0.36	+2.09	+2.20	+2.12	+2.00
58	-84						
60	-88						
62	-93						
64	-94						
66	-93	+0.32	+0.20	+1.70	+1.83	+1.76	+1.66
68	-91						
70	-91						
72	-85						
74	-77						
76	-80	+0.21	+0.14	+1.39	+1.50	+1.43	+1.36
78	-82						
80	-82						
82	-83						
84	-66						
86	-66	+0.19	+0.16	+1.09	+1.19	+1.13	+1.04

A3A	E/W						
Depth Feet	Initial 5/1/64	DEFL 8/24/64	DEFL 6/13/65	DEFL 2/23/76	DEFL 12/5/77	DEFL 8/22/78	DEFL 1979
88	-70						
90	-76						
92	-79						
94	-78						
96	-81	+0.13	+0.11	+1.09	1.18	1.15	+1.07
98	-78						
100	-75						
102	-72						
104	-86						
106	-85						
108	-84	+0.06	+0.07	+0.42	+0.47	+0.43	+0.48
110	-56						
112	-56			+0.17	+0.20	+0.16	+0.22
114	-55	+0.04	+0.05				
116	-55						
118	-54						
120	-56	+0.02	+0.02	+0.07	+0.06	+0.06	+0.11
122	-47						
124	-50	+0.07	+0.05				
126	-42						
128	-43						
130	-49						
132	-55	+0.05	+0.05				
134	-58						
136	-82						
138	-80						

A4A	N/S			E/W		
Depth Feet	Initial 4/17/64	DEFL 8/24/64	DEFL 6/15/65	Initial 4/22/64	DEFL 8/24/64	DEFL 6/15/64
3	17	+1.63	+1.08	73	-0.79	-0.53
4.5	15			76		
6	13			78		
8	9			81		
9.5	9			83		
11	10			83		
13.5	22	+1.46	+0.95	112	-0.72	-0.48
15	17			111		
16.5	19			111		
18.5	21			114		
20	27			109		
21.5	28			107		
24	17	+1.29	+0.90	110	-0.65	-0.46
25.5	24			111		
27	26			110		
29	24			108		
30.5	28			108		
32	29			107		
34.5	30	+1.17	+0.78	109	-0.55	-0.45
36	30			109		
37.5	30			109		
39.5	30			105		
41	33			105		
42.5	33			105		
45	32	+1.04	+0.67	105	-0.46	-0.39
46.5	28			105		
48	30			105		
50	28			101		
51.5	28			97		
53	27			94		
55.5	26	+0.98	+0.64	107	-0.40	-0.31
57	28			106		
58.5	31			106		
60.5	33			100		
62	33			98		
63.5	34			98		
66	27	+0.83	+0.51	92	-0.33	-0.28
67.5	17			78		
69	23			81		
71	22			82		
72.5	19			80		
74	13	+0.71	+0.43	81		
76.5	26	+0.68	+0.40	81	-0.27	-0.23
78	30			81		
79.5	27			84		
81.5	23			81		
83	27			83		

A4A	N/S			E/W		
Depth Feet	Initial 4/17/64	DEFL 8/24/64	DEFL 6/15/65	Initial 4/22/64	DEFL 8/24/64	DEFL 6/15/64
				84		
84.5	25			76	-0.19	-0.18
87	19	+0.60	+0.44	73		
88.5	23			73		
90	27			69		
92	29			69		
93.5	29			71		
95	28			76	-0.13	-0.10
97.5	28	+0.48	+0.35	77		
99	27			77		
100.5	26			76		
102.5	24			77		
104	24			78		
105.5	22			83	-0.12	-0.13
108	31	+0.39	+0.31	83		
109.5	31			83		
111	31			82		
113	29			85		
114.5	29			87		
116	26			81	-0.07	-0.06
118.5	24	+0.26	+0.27	88		
120	28			92		
121.5	27			87		
123.5	28			88		
125	28			90		
126.5	28			80	-0.02	0
129	17	+0.19	+0.19	82		
130.5	23			76		
132	27			74		
134	27			73		
135.5	27			73		
137	25			75	-0.02	-0.02
139.5	12	+0.08	+0.07	79		
141	10			81		
142.5	11			79		
144.5	13			78		
146	14			0		
147.5	17					

A5A	N/S					
Depth Feet	Initial 4/20/64	DEFL 8/25/64	DEFL 6/15/65	DEFL 1979		
2						
4	+163	+0.80	+0.28	+0.10		
6	+152					
8	+151					
10	+151					
12	+150					
14	+138	+0.70	+0.29	+0.14		
16	+139					
18	+139					
20	+143					
22	+144					
24	+145	+0.06	+0.24	+0.10		
26	+145					
28	+147					
30	+147					
34	+144	+0.48	+0.19	+0.04		
36	+143					
38	+144					
40	+145					
42	+145					
44	(+129)					
46	+146	+0.27	+0.08	-0.04		
48	+145					
50	+144					
52	+143					
54	+139					
56	+125	+0.20	+0.09	+0.01		
58	+123					
60	+122					
62	+120					
64	+118					
66	+126	+0.10	+0.01	-0.06		
68	+122					
70	+120					
72	+116					
74	+112	+0.05	-0.03	-0.07		
76	+116					
78	+115	+0.04	-0.04	-0.08		
80	+103					
82	+102					
84	+102					
86	+107					
88	+110	+0.08	+0.07	-0.05		
90	+107					
92	+106					
94	+106					
96	+104					

A5A	N/S					
Depth Feet	Initial 4/20/64	DEFL 8/25/64	DEFL 6/15/65	DEFL 1979		
98	+94	+0.06	-0.02	-0.01		
100	+99					
102	+101					
104	+94					
106	+98					
108	+107	0	-0.07	-0.11		
110	+106					
112	+106					
114	+104					
116	+103					
118	+105	+0.05	-0.05	-0.06		
120	+108					
122	+104					
124	+104					
126	+105					
128	+102					
130	+ 99	+0.08	+0.02	+0.06		
132	+ 94					
134	+ 94					
136	+ 95					
138	+ 99					
140	+ 94	+0.03	+0.02	+0.04		
142	+ 95					
144	+ 94					
146	+ 90					

A5A	E/W					
Depth Feet	Initial 4/20/64	DEFL 8/25/64	DEFL 6/15/65	DEFL 1979		
2						
4	124	-1.72	-1.52	-0.06		
6	120					
8	116					
10	117					
12	119					
14	128	-1.58	-1.38	-0.08		
16	130					
18	131					
20	133					
22	136					
24	130	-1.38	-1.22	-0.03		
26	131					
28	133					
30	135					
32	139					
34	136	-1.17	-1.08	-0.01		
36	130					
38	127					
40	125					
42	125					
44	129					
46	134	-1.01	-0.92	-0.07		
48	136					
50	135					
52	135					
54	139					
56	133	-0.81	-0.77	-0.04		
58	129					
60	127					
62	126					
64	128					
66	112	-0.69	-0.72	+0.01		
68	111					
70	111					
72	112					
74	113					
76	115					
78	116	-0.58	-0.66	+0.02		
80	116					
82	115					
84	116					
86	115					
88	114	-0.51	-0.57	+0.02		
90	115					
92	119					
94	121					

A5A E/W						
Depth Feet	Initial 4/20/64	DEFL 8/25/64	DEFL 6/15/65	DEFL 1979		
96	118					
98	119	-0.36	-0.45	+0.01		
100	116					
102	115					
104	113					
106	125					
108	124	-0.24	-0.37	0		
110	125					
112	126					
114	127					
116	129					
118	125	-0.14	-0.23	+0.02		
120	121					
122	123					
124	127					
126	128					
128	126					
130	122	-0.04	-0.16	+0.04		
132	121					
134	122					
136	125					
138	128					
140	127	0	-0.02	0		
142	127					
144	122					
146	128					

A106	N/S			E/W		
Depth Feet	Initial 7/17/64	DEFL 8/25/64	DEFL 6/15/65	Initial 7/21/64	DEFL 8/25/64	DEFL 6/15/65
1	0	-0.03	+0.39	131	+0.06	+0.31
2.5	0			130	+0.05	
4.5	0			138		
6	- 4			134		
7.5	- 7			136		
9.5	-15			120		
11	-15			106	+0.13	+0.41
12.5	-15			100		
14.5	-19			104		
16	-19	-0.13	+0.28	107		
17.5	-17			102		
19.5	-16			107		
21	-16			110	+0.10	+0.45
22.5	-18			113		
24.5	-20			117		
26	-20	-0.16	+0.19	112		
27.5	-17			113		
29.5	-19			110		
31	-32			101	+0.18	+0.48
32.5	-29			110		
34.5	-30			107		
36	-35	-0.20	+0.07	102		
37.5	-54			105		
39.5	-55			107		
41	-54			115	+0.20	+0.46
42.5	-53			106		
44.5	-54			99		
46	-53	-0.33	-0.09	96		
47.5	-55			93		
49.5	-58			90		
51	-65			87	+0.18	+0.39
52.5	-60			86		
54.5	-60			89		
56	-66	-0.31	-0.07	91		
57.5	-63			92		
59.5	-78			101		
61	-75			100	+0.16	+0.39
62.5	-71			101		
64.5	-71			99		
66	-71	-0.33	-0.08	97		
67.5	-69			96		
69.5	-58			79		
71	-58			70		
72.5	-59	-0.03	-0.08	72	+0.11	+0.33
74.5	-60			66		
76	-63			73		
77.5	-62			68		

A106	N/S			E/W		
Depth Feet	Initial 7/17/64	DEFL 8/25/64	DEFL 6/15/65	Initial 7/21/64	DEFL 8/25/64	DEFL 6/15/65
79.5	-57			65		
81	-57			64		
82.5	-57			63		
84.5	-57	-0.30	-0.11	59		
86	-57			56	+0.12	+0.33
87.5	-62			55		
89.5	-65			66		
91	-65			69		
92.5	-66			70		
94.5	-68			69		
96	-68	-0.37	-0.17	67		
97.5	-72			66	+0.09	+0.20
99.5	-53			47		
101	-53			43		
102.5	-53			42		
104.5	-53			38		
106	-51	-0.31	-0.14	36		
107.5	-49			33		
109.5	-19			51		
111	-24			51	+0.09	+0.11
112.5	-27			55		
114.5	-27			55		
116	-32	-0.23	-0.08	56		
117.5	-38			64		
119.5	-65			74		
121	-57			76		
122.5	-53			76		
124.5	-52			74		
126	-52	-0.24	-0.13	74		
127.5	-49			74		
129.5	-31			59	+0.14	+0.19
131	-30			56		
132.5	-30			60		
134.5	-30			61		
136	-30	-0.21	-0.07	60		
137.5	-30			58		
139.5	-23			71		
141	-26			74		
142.5	-26			75		
144.5	-22	-0.22	-0.10	74	+0.08	+0.13
146	-28			76		
147.5	-27			78		
149.5	-10			73		
151	- 5	-0.21	-0.06	67		
152.5	- 9			67		
154.5	- 9			65		
156	- 9			65		

A106	N/S			E/W		
Depth Feet	Initial 7/17/64	DEFL 8/25/64	DEFL 6/15/65	Initial 7/21/64	DEFL 8/25/64	DEFL 6/15/65
157.5	-14			64	+0.06	+0.10
159.5	-25	-0.13	-0.04	61		
161	-28			61		
162.5	-27			59		
164.5	-25			61		
166	-26			61		
167.5	-27			76		
169.5	-25	-0.07	-0.02	80		
171	-25			81		
172.5	-25			80	+0.01	+0.09
174.5	-26			74		
176	-26			71		
177.5	-26	-0.03	-0.05	66		
179.5	-27			40		
181	-29			37	+0.01	+0.02
182.5	-30			36		
184.5	-30			38		
186	-30			38		

A112S	N/S		E/W			
Depth Feet	Initial 11/22/77	DEFL 8/22/78	Initial 11/22/77	DEFL 8/22/78		
1.5	828	+0.16	-105	+0.14		
2.5	818	+0.08	-110	+0.12		
4	831	+0.05	-102	+0.09		
6	855	+0.03	-109	+0.09		
7.5	867	+0.03	-109	+0.09		
9	888	+0.03	-111	+0.09		
11	909	+0.04	- 60	+0.07		
12.5	882	+0.04	- 69	+0.08		
14	870	+0.03	- 86	+0.08		
16	851	+0.04	- 93	+0.07		
17.5	832	+0.04	- 99	+0.07		
19	840	+0.03	- 81	+0.07		
21	931	+0.03	- 81	+0.07		
22.5	911	+0.03	-344	+0.08		
24	863	+0.04	-420	+0.08		
26	776	+0.04	-395	+0.07		
27.5	726	+0.02	-341	+0.06		
29	694	0	-296	+0.07		
31	505	-0.02	-423	+0.07		
32.5	531	-0.07	-436	+0.06		
34	605	-0.10	-432	+0.05		
36	731	-0.12	-399	+0.04		
37.5	800	-0.10	-384	+0.02		
39	733	-0.06	-337	+0.01		
41	681	+0.01	-130	0		
42.5	661	+0.02	-119	-0.01		
44	651	+0.02	- 93	-0.01		
46	645	+0.03	- 77	-0.01		
47.5	643	+0.03	- 69	0		
49	664	+0.04	- 30	+0.01		
51	613	+0.03	- 97	+0.03		
52.5	665	+0.03	-110	+0.02		
54	669	+0.02	-121	+0.01		
56	717	+0.01	-139	+0.01		
57.5	721	+0.02	-169	+0.01		
59	717	+0.03	-176	+0.02		
61	415	+0.03	-514	+0.01		
62.5	417	+0.02	-538	0		
64	406	+0.01	-553	0		
66	348	+0.01	-578	0		
67.5	297	+0.01	-573	0		
69	155	+0.01	-571	0		
71	122	+0.01	-308	-0.01		
72.5	132	+0.01	-276	-0.01		
74	153	+0.01	-246	0		
76	169	0	-216	0		
77.5	186	0	-195	0		

A112S	N/S		E/W			
Depth Feet	Initial 11/22/77	DEFL 8/22/78	Initial 11/22/77	DEFL 8/22/78		
79	211	0	-205	0		
81	367	0	+117	-0.01		
82.5	363	-0.01	+152	-0.01		
84	351	-0.01	+145	-0.01		
86	370	-0.01	+109	0		
87.5	477	0	+ 76	0		
89	521	0	+ 49	0		
91	519	-0.01	- 98	0		
92.5	569	-0.02	-123	0		
94	591	-0.01	-172	0		
96	600	0	-237	0		
97.5	600	0	-291	0		

A1005S	N/S			E/W		
Depth Feet	Initial 11/22/77	DEFL 8/23/78	DEFL 1979	Initial 11/22/77	DEFL 8/23/78	DEFL 1979
1	+310	-0.07	+0.01	- 92	+0.02	+0.26
3	+291			- 97		
5	+259			-115		
7	+259			-136		
9	+318			-163		
11	+294	-0.02	+0.06	- 85	+0.01	+0.27
13	-306			- 58		
15	-342			- 30		
17	-388			- 32		
19	-364			- 17		
21	-439	-0.03	+0.11	+212	+0.01	+0.12
23	-475			+200		
25	-478			+195		
27	-507			+231		
29	-484			+203		
31	- 65	0	-0.07	- 88	-0.02	+0.23
33	- 91			- 74		
35	-157			- 86		
37	-221			-120		
39	-276			-124		
41	-904	0	+0.09	+ 92	-0.04	+0.17
43	-952			+ 97		
45	-972			+ 85		
47	-962			+ 57		
49	-980			+ 46		
51	-1230	+0.02	+0.16	+ 79	-0.03	+0.11
53	-1259			+ 75		
55	-1265			+ 77		
57	-1239			+ 81		
59	-1252			+ 74		
61	-809	-0.02	+0.09	-156	+0.05	+0.12
63	-777			-155		
65	-764			-158		
67	-717			-162		
69	-757			-157		
71	-762	0	+0.04	-186	+0.01	+0.02
73	-732			-205		
75	-725			-215		
77	-723			-249		

B-1 N/S						
Depth Feet	Initial 5/4/64	DEFL 8/26/64	DEFL 6/11/65	DEFL 1979		
2	+22	-2.26	-1.99	-1.82		
4	+19					
6	+27					
8	+27					
10	+18					
12	+26	-2.12	-1.85	-1.75		
14	+19					
16	+19					
18	+16					
20	+24					
22	+25	-1.89	-1.64	-1.61		
24	+28					
26	+29					
28	+31					
30	+28					
32	+29	-1.60	-1.39	-1.43		
34	+25					
36	+20					
38	+19					
40	+ 1					
42	- 2	-1.39	-1.23	-1.27		
44	+ 2					
46	- 3					
48	- 5					
50	- 5					
52	0	-1.19	-1.08	-1.13		
54	+ 4					
56	+ 1					
58	+ 3					
60	+ 6					
62	+ 6	-0.97	-0.91	-0.98		
64	+12					
66	+10					
68	+ 9					
70	+11					
72	+12	-0.72	-0.65	-0.83		
74	+13					
76	+17					
78	+14					
80	+ 3					
82	+ 5	-0.51	-0.44	-0.61		
84	+ 2					
86	0					
88	+ 1					
90	+ 9					
92	+11	-0.31	-0.28	-0.53		
94	+13					

B-1 N/S

Depth Feet	Initial 5/4/64	DEFL 8/26/64	DEFL 6/11/65	DEFL 1979		
96	+14					
98	+14					
100	+17					
102	+15	-0.19	-0.20	-0.50		
104	+24					
106	+25					
108	+25					
110	+28	-0.04	-0.05	-0.35		
112	+25			-0.31		
114	+27					
116	+27					
118	+27					
120	+11					
122	+ 9			-0.15		
124	+16					
126	+20					
128	+19					
130	+ 7					
132	+ 8			-0.04		
134	+17					
136	+16			-0.01		
138	+21					
140	+26					
142	+20					

B-1	E/W					
Depth Feet	Initial 4/22/64	DEFL 8/26/64	DEFL 6/11/65	DEFL 1979		
2	-150	-0.73	-0.90	-1.50		
4	-115					
6	-114					
8	-115					
10	-116	-0.70	-0.85	-1.38		
12	-119					
14	-134					
16	-134					
18	-139					
20	-160	-0.65	-0.78	-1.24		
22	-164					
24	-149					
26	-148					
28	-147					
30	-142	-0.61	-0.73	-1.15		
32	-143					
34	-134					
36	-134					
38	-136					
40	-128	-0.54	-0.67	-1.07		
42	-129					
44	-133					
46	-133					
48	-132					
50	-132	-0.49	-0.58	-0.97		
52	-136					
54	-137					
56	-133					
60	-142	-0.44	-0.51	-0.86		
62	-142					
64	-143					
66	-143					
68	-141					
70	-145	-0.37	-0.45	-0.71		
72	-147					
74	-149					
76	-148					
78	-147					
80	-176	-0.26	-0.34	-0.58		
82	-174					
84	-166					
86	-167					
88	-168					
90	-161	-0.22	-0.26	-0.41		
92	-168					
94	-163					
96	-163					

B-1 E/W

Depth Feet	Initial 4/22/64	DEFL 8/26/64	DEFL 6/11/65	DEFL 1979		
98	-163					
100	-170	-0.14	-0.15	-0.31		
102	-169					
104	-168					
106	-167					
108	-168					
110	-169	-0.02	-0.02	-0.16		
112	-170					
114	-169					
116	-169					
118	-169					
120	-163			-0.10		
122	-163					
124	-159					
126	-160					
128	-156					
130	-147			-0.08		
132	-145					
134	-145					
136	-145			-0.02		
138	-146					
140	-146					
142	-147					

B-2	N/S			E/W		
Depth Feet	Initial 5/9/64	DEFL 8/26/64	DEFL 6/18/65	Initial 4/10/64	DEFL 8/26/64	DEFL 6/18/65
1.5	78	-1.61	-0.58	-126	-1.11	-1.25
3	74			-125		
4.5	71			-125	-1.04	-1.17
7	50			-136		
8.5	47			-138		
10	52			-133	-0.96	-1.08
12.5	87			-139		
14	78			-133		
15.5	79			-129	-0.81	-1.05
18	88			-130		
19.5	86			-127	-0.79	-1.04
21	99	-1.25	-0.87	-117	-0.70	-0.99
23.5	105	-1.25	-0187	-117		
25	107			-117		
29	83			-100		
30.5	91			-102	-0.59	-0.85
32	84			-105		
34.5	102	-1.11	-0.80	- 82	-0.51	-0.73
36	94			- 75		
37.5	100			- 75		
40	82			- 62	-0.45	-0.65
41.5	88			- 72		
43	89	-1.01	-0.74	- 71		
45.5	94	-1.01	-0.74	- 90	-0.26	-0.39
47	108			- 92		
48.5	110			- 93		
51	90			- 93	-0.14	-0.34
52.5	88			- 97		
54	90			- 95		
56.5	99	-0.91	-0.65	- 95	-0.17	-0.33
58	96			- 98		
59.5	92			- 93	-0.18	-0.32
62	94			- 91		
63.5	94			- 88		
65	95			- 88	-0.19	-0.32
66.5	97	-0.81	-0.59	- 95		
68	87			- 86		
70.5	96	-0.72	-0.57	- 84	-0.29	-0.35
73	78			- 87		
74.5	78			- 87		
76	80	-0.06	-0.49	- 82	-0.19	-0.25
78.5	64	-0.56	-0.47	- 84		
80	62			- 84	-0.12	-0.16
80.5	64			- 82		
84	72			- 73		
85.5	73	-0.48	-0.41	- 74	-0.21	-0.22
87	70			- 75		

B-2	N/S			E/W		
Depth Feet	Initial 5/9/64	DEFL 8/26/64	DEFL 6/18/65	Initial 4/10/64	DEFL 8/26/64	DEFL 6/18/65
89.5	84			-68	-0.31	-0.33
91	86			-71		
92.5	88			-72		
95	85	-0.38	-0.31	-70	-0.35	-0.39
96.5	86			-71		
98	85			-72		
100.5	69			-68	-0.29	-0.31
102	69			-61		
103.5	69			-54	-0.17	-0.18
106	74	-0.22	-0.16	-69		
107.5	75			-61		
109	76			-63	-0.15	-0.16
111.5	85			-64		
113	90			-65		
114.5	89	-0.17	-0.11	-67	-0.15	-0.18
117	84			-61		
118.5	82			-55		
120	83			-53	-0.14	-0.16
122.5	75			-53		
124	78			-50		
125.5	77	-0.03	-0.02	-45	-0.07	-0.07
128	91			+ 4		
129.5	105			+ 2		
131	98			+ 6		
133.5	102			+20		

B-3	N/S			E/W			
Depth Feet	Initial 5/2/64	DEFL 8/26/64	DEFL 6/14/65	Initial 4/09/64	DEFL 8/26/64	DEFL 6/14/65	
2	135	-1.16	-0.96	-49	-1.73	-2.14	
4	146			-53			
5.5	147			-54			
7	148			-51			
9	187	-1.08	-0.89	-62	-1.67	-2.09	
10.5	188			-64			
12	190			-64			
14	201			-75			
15.5	202			-75			
17	201			-78			
19	199	-0.95	-0.81	-88	-1.56	-1.95	
20.5	199			-92			
22	200			-90			
24	201			-85			
25.5	200			-82			
27	200			-82			
29	202	-0.83	-0.69	-89	-1.36	-1.71	
30.5	204			-82			
32	203			-83			
34	199			-82			
35.5	198			-84			
37	198			-81			
39	190	-0.74	-0.53	-79	-1.29	-1.57	
40.5	185			-76			
42	184			-75			
44	190			-73			
45.5	193			-71			
47	191	-0.57	-0.44	-72	-1.12	-1.35	
50.5	186			-70			
52	184			-72			
54	167			-61			
55.5	172			-59			
57	169	-0.47	-0.37	-67	-0.92	-1.12	
60.5	177			-65			
62	176			-63			
64	176			-69			
65.5	173			-68			
67	170	-0.37	-0.33	-66			
69	162			-63	-0.73	-0.89	
70.5	164	-0.35	-0.30	-65			
72	167			-64	-0.67	-0.82	
74	160			-59			
75.5	159			-58			
77	159			-52			
79	152	-0.24	-0.23	-46	-0.53	-0.67	
80.5	148			-44			
82	150			-45			

B-3	N/S			E/W			
Depth Feet	Initial 5/2/64	DEFL 8/26/64	DEFL 6/14/65	Initial 4/09/64	DEFL 8/26/64	DEFL 6/14/65	
82	150			-45			
84	146			-39			
85.5	148			-35			
87	148			-34			
89	146	-0.25	-0.27	-42	-0.37	-0.44	
90.5	146			-41			
92	146			-39			
94	162			-43			
95.5	160			-39			
97	153			-38			
99	163	-0.19	-0.17	-38	-0.19	-0.24	
100.5	163			-40			
102	162			-42			
104	162			-52			
105.5	161			-54			
107	161			-52			
109	131	-0.04	+0.01	-26	-0.07	-0.06	
110.5	130			-26			
112	130			-27			
114	116			-18			
115.5	114			-18			

B-4	N/S			E/W		
Depth Feet	Initial 4/23/64	DEFL 5/22/64	DEFL 1979	Initial 4/23/64	DEFL 7/9/64	DEFL 1979
2	-21	-1.21	-1.85	-110		
4	-18			- 93	+1.19	-0.37
6	-17			- 93		
8	-15	-1.24	-1.76	- 95		
10	-15			- 94		
12	-18			-102		
14	-22			- 86	+1.04	-0.34
16	-31	-1.22	-1.57	- 86		
18	-34			- 89		
20	-38			- 91		
22	-37			- 89		
24	+ 4			-116	+0.88	-0.25
26	+ 6	-1.26	-1.41	-114		
28	+ 4			-112		
30	+ 6			-110		
32	+ 7			-106		
34	+ 5			- 90	+0.78	-0.28
36	+ 8			- 84		
38	+ 8	-1.11	-1.16	- 83		
40	+12			- 79		
42	+13			- 80		
44	+15			- 72		
46	+17	-1.02	-1.08	- 64	+0.68	-0.26
48	+22			- 60		
50	+17			- 60		
52	+16			- 60		
54	+13			- 60		
56	+12			- 60	+0.58	-0.26
58	+11	-0.90	-0.91	- 64		
60	+12			- 60		
62	+12			- 63		
64	+13			- 76		
66	+15			- 64	+0.49	-0.32
68	+ 9	-0.76	-0.08	- 62		
70	+ 9			- 63		
72	+ 8			- 64		
74	+ 9			- 63		
76	+ 9			- 58		
78	+ 9	-0.68	-0.71	- 59	+0.42	-0.29
80	+10			- 61		
82	+10			- 61		
84	+10			- 63		
86	+10			- 59		
88	+10	-0.54	-0.62	- 54	+0.37	-0.24
90	+11			- 52		
92	+10			- 52		
94	+10			- 53		

B-4	N/S			E/W		
Depth Feet	Initial 4/23/64	DEFL 5/22/64	DEFL 1979	Initial 4/23/64	DEFL 7/9/64	DEFL 1979
96	+ 9			- 55		
98	+10			- 49	+0.32	-0.23
100	+10			- 52		
102	+10			- 52		
104	+ 9			- 53		
106	+ 5			- 53		
108	+22			- 37	+0.31	-0.25
110	+25	-0.43	-0.42	- 36		
112	+21			- 35		
114	+20			- 33		
116	+15			- 32		
118	+26	0.29	-0.31	- 37	+0.27	-0.17
120	+27			- 42		
122	+28			- 45		
124	+28			- 46		
126	+27			- 47		
128	+29			- 54		
130	+29	-0.08	-0.09	- 62	+0.15	-0.14
132	+35			- 64		
134	+33			- 73		
136	+37			- 71		
138	+35		-0.02	- 74		
140	+51	-0.02		- 85	+0.04	
142	+54			- 86		
144	+58			- 90		
146	+61	-0.01		- 99		

B101	N/S			E/W		
Depth Feet	Initial 8/25/64	DEFL 1965	DEFL 1979	Initial 8/25/64	DEFL 1965	DEFL 1979
2						
4	-25	-0.17	+0.53	+15	+0.18	+0.01
6	-25			+14		
8	-25			+14		
10	-19			+ 9		
12	-12			+ 9		
14	-12	-0.23	+0.52	+ 3	+0.15	-0.02
16	-15			+ 6		
18	-12			+ 4		
20	-21			+ 1		
22	-30			- 6		
24	-33	-0.26	+0.45	- 9	+0.15	-0.07
26	-43			-13		
28	-47			-11		
30	-44			- 6		
32	-42			- 1		
34	-42	-0.30	+0.38	0	+0.17	-0.06
36	-41			- 1		
38	-42			- 2		
40	-44			- 1		
42	-49			- 2		
44	-49	-0.28	+0.32	- 4	-0.19	-0.04
46	-51			- 5		
48	-55			- 7		
50	-49			- 9		
52	-44			- 9		
54	-42	-0.25	+0.32	-11	+0.11	-0.07
56	-40			-10		
58	-42			- 6		
60	-40			- 6		
62	-39			- 1		
64	-36	-0.23	+0.31	- 4	+0.06	-0.08
66	-36			0		
68	-36			- 2		
70	-31			+ 2		
72	-30			+ 6		
74	-	-0.18	+0.32	-	+0.05	-0.02
76	-22			0		
78	-28			+ 5		
80	-23			+ 5		
82	-21			+ 5		
84	-20	-0.13	+0.34	+ 1	+0.05	0
86	-28			- 1		
88	-26			- 1		
90	-29			+ 2		
92	-25			+ 1		
94	-27	-0.05	+0.32	+ 1	-0.02	-0.08

B101	N/S			E/W		
Depth Feet	Initial 8/25/64	DEFL 1965	DEFL 1979	Initial 8/25/64	DEFL 1965	DEFL 1979
96	-29			+ 1		
98	-30			0		
100	-33			- 2		
102	-33			- 5		
104	-32	+0.01	+0.32	- 4	-0.04	-0.07
106	-27			- 2		
108	-25			- 4		
110	-22			0		
112	-15			+ 1		
114	-17	+0.04	+0.34	0	-0.07	-0.05
116	-15			- 1		
118	-15			0		
120	- 8			+ 2		
122	0			+ 7		
124	+ 1	+0.07	+0.37	+10	-0.03	-0.02
126	0			+12		
128	- 1			+11		
130	- 7			+13		
132	-11			+17		
134	-11	+0.12	+0.37	+17	0	+0.04
136	-13			+20		
138	-14			+27		
140	- 7			+28		
142	- 3			+59		
144	- 4	+0.15	+0.37	+61	+0.04	+0.13
146	- 5			-		
148	- 7			+68		
150	- 3			+78		
152	- 5			+87		
154	- 3	+0.12	+0.34	+98	+0.05	+0.20
156	- 9			+110		
158	-15			+117		
160	-21			+108		
162	-131			+89		
164	-139	+0.07	+0.17	+77	+0.03	0.16
166	-165			+69		
	Base of readings					
168						
170						
172						
174						
176						

B113	N/S			E/W		
Depth Feet	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65
4	61	-0.98	-0.89	-87	+0.65	+0.37
6	60			-87		
7.5	59			-87		
9	51			-89		
11	47			-51		
12.5	46			-47		
14	47	-0.09	-0.83	-46	+0.56	+0.33
16	46			-46		
17.5	44			-44		
19	44			-40		
21	26			-21		
22.5	32			-22		
24	27	-0.85	-0.75	-18	+0.47	+0.25
26	27			-20		
27.5	30			-21		
29	28			-19		
31	20			-16		
32.5	15			-14		
34	17	-0.86	-0.79	-14	+0.49	+0.27
36	21			-14		
37.5	20			-18		
39	20			-16		
41	62			-46		
42.5	63			-50		
44	69	-0.84	-0.74	-53	+0.45	+0.27
46	71			-53		
47.5	75			-50		
49	74			-34		
51	72			-17		
52.5	72			-18		
54	67	-0.64	-0.53	-16	+0.44	+0.32
56	67			-21		
57.5	60			-22		
59	60			-23		
61	49			-31		
62.5	45	-0.53	-0.43	-35	+0.45	+0.34
64	41			-48		
66	37			-51		
67.5	26			-56		
69	28			-58		
71	14			-46		
72.5	14			-33		
74	13	-0.53	-0.42	-29		
76	14			-20		
77.5	14			-18		
79	16			-18		
81	34			-18		

B113	N/S			E/W		
Depth Feet	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65
82.5	36			-31		
84	38	-0.51	-0.42	-29	+0.30	+0.22
86	38			-34		
87.5	42			-38		
89	49			-43		
91	53			-39		
92.5	54			-46		
94	56	-0.43	-0.35	-50	+0.23	+0.15
96	55			-50		
97.5	55			-50		
99	56			-50		
101	50			-53		
102.5	47			-70		
104	44	-0.28	-0.32	-77	+0.06	+0.01
106	34			-77		
107.5	31			-63		
109	35			-47		
111	15			-50		
112.5	14			-48		
114	20	-0.28	-0.20	-45	-0.06	-0.10
116	28			-41		
117.5	42			-41		
119	57			-40		
121	35			-57		
122.5	47			-57		
124	64	-0.18	-0.16	-54	-0.11	-0.16
126	78			-40		
127.5	65			-25		
129	50			-22		
131	28			-19		
132.5	28			-24		
134	33	-0.09	-0.07	-33	-0.11	-0.15
136	38			-33		
137.5	38			-30		
139	34			-30		
141	20			-20		
142.5	21			-18		
144	22	-0.02	0	-17	-0.13	-0.14
146	19			-16		
147.5	14			-16		
149	13			-18		
151	18			- 2		
152.5	15			- 1		
154	11	-0.01	+0.02	+ 5	-0.17	-0.09
156	7			+ 5		
157.5	2			+ 6		
159	-1			+11		

B113	N/S			E/W		
Depth Feet	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65	Initial 7/3/64	DEFL 8/25/64	DEFL 6/11/65
161	- 7			+25		
162.5	- 6			+29		
164	- 6	+0.01	+0.04	+39	-0.05	-0.09
166	- 5			+36		
167.5	- 5			+40		
169	- 2	+0.01	+0.01	+37		
171	+18			+29		

C1B	N/S		E/W			
Depth Feet	Initial 4/14/64	DEFL 7/24/64	Initial 4/11/64	DEFL 5/26/64		
1.5	-70	+0.28	- 4	-0.56		
3	-68		- 3			
4.5	-65	+0.22	- 3	-0.51		
7	-59		-18			
8.5	-60		-16			
10	-58	+0.13	-14	-0.48		
12.5	-56		- 7			
14	-53		- 9			
15.5	-47	+0.12	- 6	-0.48		
18	-41		- 9			
19.5	-41		- 8			
21	-43	+0.44	- 6	-0.46		
23.5	-52		+ 4			
25	-51	+0.45	+ 1	-0.48		
26	-49		0			
29	-34		-20			
30.5	-36		-18			
32	-36	+0.39	-19	-0.52		
34.5	-36		- 9			
36	-34		-12			
37.5	-37		-19			
40	-29	+0.33	- 3	-0.55		
41.5	-31		- 4			
43	-31		- 5			
45.5	-49	+0.27	- 7	-0.54		
47	-49		- 9			
48.5	-48		-11			
51	-24		- 4			
52.5	-21		- 4			
54	-21	+0.28	- 5	-0.51		
56.5	-15		- 1			
58	-14		+ 3			
59.5	-14	+0.25	+ 5	-0.44		
62	-20		+ 8			
63.5	-21		+ 8			
65	-25	+0.23	+ 6	-0.38		
66.5	-33		+ 3			
68	-43		- 3			
70.5	-39	+0.20	- 4	-0.33		
73	-33		+ 5			
74.5	-32		+ 5			
76	-33		+ 6			
78.5	-32	+0.18	+17	-0.21		
80	-34		+ 9			
81.5	-36		+ 8			
84	-42	+0.12	+10	-0.20		
85.5	-40		+ 8			

C1B	N/S		E/W			
Depth Feet	Initial 4/14/64	DEFL 7/24/64	Initial 4/11/64	DEFL 5/26/64		
87	-42	+0.10	+ 6	-0.15		
89.5	-30		+ 6			
91	-30		+ 6			
92.5	-25	+0.03	+ 9	-0.05		
			- 3			

C100	N/S			E/W		
Depth Feet	Initial 5/19/64	DEFL 8/27/64	DEFL 6/5/65	Initial 5/19/64	DEFL 8/27/64	DEFL 6/6/65
1	207	+1.98	+1.98	111	-1.15	-0.62
3	205			107		
4.5	197			106		
6	202			105		
8.5	197	+1.86	+1.80	105	-1.08	-0.76
10	196			99		
11.5	199			87		
13.5	205			87		
15	211			87		
16.5	214			88		
19	192	+1.61	+1.51	88	-0.79	-0.56
20.5	185			88		
22	184			85		
24	180			85		
25.5	178			85		
27	181			84	-0.66	-0.41
29.5	181	+1.47	+1.44	69		-0.36
31	176			62		
32.5	176			62		
34.5	178			57		
36	179			56		
37.5	180			56	-0.52	-0.33
40	175	+1.30	+1.25	50		-0.34
41.5	121			52		
43	171			52		
45	166			48		
46.5	174			52		
48	180			63	-0.45	-0.32
50.5	186	+1.06	+1.07	58		
52	184			54		
53.5	185			54		
55.5	186			53		
57	186			52	-0.39	-0.32
58.5	175			55		
61	171	+0.87	+0.93	36		-0.28
62.5	173			34		
64	173			33		
66	173			36		
67.5	169			36	-0.32	-0.30
69	173			33		
71	173	+0.77	+0.86	25	-0.30	-0.29
72.5	169			25		
74	168			25	-0.25	-0.25
76	169			27	-0.23	-0.22
77.5	167			27		
79	167			30		
81.5	155	+0.55	+0.64	18	-0.17	-0.17

C100	N/S			E/W		
Depth Feet	Initial 5/19/64	DEFL 8/27/64	DEFL 6/5/65	Initial 5/19/64	DEFL 8/27/64	DEFL 6/6/65
83	153			23		
84.5	150			23		
86.5	150			25	-0.18	-0.13
88	151			26		
89.5	154			26		
92	161	+0.41	+0.56	42	-0.11	-0.03
93.5	168			38		
95	172			36		
97	177			27	+0.07	+0.15
98.5	177			14		
100	172			8		
102.5	126	+0.32	+0.44	- 1	-0.10	-0.09
104	128			-10		
105.5	129			-17		
107.5	136			-11	-0.16	-0.16
109	141			- 8		
110.5	144			- 8		
113	130	+0.25	+0.33	- 6	-0.16	-0.15
114.5	125			- 6		
116	120			-14		
118	120			-14	-0.08	-0.08
119.5	119			- 9		
121	123			-11		
123.5	108	+0.15	+0.21	-14	-0.10	-0.07
125	113			-18		
126.5	114			-22	-0.13	-0.09
128.5	112			- 9		
130	110			-16		
131.5	106			-11		
134	141	+0.09	+0.12	5	+0.02	-0.01
135.5	144			- 5		
137	142			-11	+0.01	0
139	116			- 8		
140.5	112			-13		
142.5	107			-15		
144.5	119	+0.09	+0.11	-10	-0.04	-0.05
146	121			- 9		
147.5	123			0	-0.02	-0.03
148.5	121			7		
151	121			11	+0.03	+0.01
152.5	126			16		
155	127			- 5		
156.5	128	-0.03	-0.03	0	+0.01	+0.03
158	135			3		
160	128			11		

C103	N/S		E/W			
Depth Feet	Initial 6/3/64	DEFL 6/7/65	Initial 6/3/64	DEFL 6/7/65		
4	176	+1.85	162	-2.38		
6	204		163			
7.5	206		165			
9	207		162			
11	211	+1.80	127	-2.45		
12.5	203		131			
14	202		132			
16	220		117			
17.5	220	+1.67	112	-2.38		
19	218		109			
21	228		96			
22.5	232		94			
24	233		95			
26	246	+1.55	90			
27.5	243		87	-2.26		
29	243		83			
31	242		77			
32.5	240		80			
34	236	+1.41	76			
36	227		75	-2.14		
37.5	221		71			
39	220		76			
41	209		86			
42.5	206	+1.35	84	-2.05		
44	204		81			
46	196		75	-2.00		
47.5	190		82			
49	196		81			
51	180	+1.20	71	-1.94		
52.5	180		65			
54	179		65			
56	188		63	-1.90		
57.5	192		60			
59	191		55			
61	164	+1.25	79	-1.84		
62.5	164		78			
64	165		75			
66	178		44			
67.5	178		47	-1.85		
69	181	+1.14	51			
71	203		88			
72.5	211		83			
74	211		80	-1.75		
76	166	+1.10	88	-1.74		
77.5	158	+1.07	97			
79	158		104			
81	168		93			

C103	N/S		E/W			
Depth Feet	Initial 6/3/64	DEFL 6/7/65	Initial 6/3/64	DEFL 6/7/65		
82.5	163		80			
84	160		75			
86	165		86			
87.5	165	+0.88	88	-1.56		
89	160		88			
91	158		87			
92.5	159		87			
94	157		87			
96	149		80			
92.5	153	+0.79	80	-1.46		
99	155		83	-1.44		
101	158		87	-1.42		
102.5	154		87			
104	153		89			
106	154		80			
107.5	158	+0.68	81			
109	159		81	-1.34		
111	159		84			
112.5	158		85			
114	154	+0.63	86			
116	191		81			
117.5	195		87			
119	196		84	-1.25		
121	193		83			
122.5	192	+0.59	81			
124	194		74			
126	223		70			
127.5	229		72	-1.15		
129	230		72			
131	230	+0.56	66	-1.08		
132.5	233		66			
134	233		67			
136	-		-			
137.5	233		63			
139	236	+0.43	70	-1.02		
141	246		71			
142.5	246		74			
144	252		80			
146	244		-			
147.5	243	+0.35	83	-0.78		
149	249	+0.32	84			
151	252		85			
152.5	255		85			
154	265		87	-0.62		
156	-		-			
157.5	272		87	-0.57		
159	270	+0.27	89	-0.53		

C103	N/S		E/W			
Depth Feet	Initial 6/3/64	DEFL 6/7/65	Initial 6/3/64	DEFL 6/7/65		
161.5	269		91			
162.5	270		97			
164	270		97	-0.39		
166	270		90			
167.5	-		-			
169	272	+0.08	90	-0.34		
171	281		83			
172.5	269		85			
174	254		84			
176	283		84	-0.21		
177.5	288	-0.06	-			
179	289		106			
181	300		106			

C109	N/S			E/W		
Depth Feet	Initial 7/18/64	DEFL 8/27/64	DEFL 6/4/65	Initial 7/14/64	DEFL 8/27/64	DEFL 6/4/65
2.5	-			-		
4	-38	+0.50	+1.30	-		
6	-18			+16	-0.31	+0.28
7.5	-13			+14		
9	-12			+17		
11	-12	+0.48	+1.08	+16	-0.30	+0.24
12.5	-12			+12		
14	-12			+12		
16	+ 9			- 6		
17.5	+10			- 5		
19	+13			- 5		
21	+21	+0.44	+0.99	- 4	-0.30	+0.19
22.5	+23			- 3		
24	+28			- 3		
26	+26			- 7		
27.5	+21			- 4		
29	+21			- 7		
31	+12	+0.41	+1.03	- 2	-0.31	+0.14
32.5	+ 7			0		
34	+ 7			+ 2		
36	+ 0			+ 3		
37.5	+12			+ 7		
39	+19			+ 7		
41	+33	+0.27	+0.87	+ 8	-0.32	+0.09
42.5	+36			+ 9		
44	+40			+ 8		
46	+47			- 7		
47.5	+45			- 3		
49	+40			- 4		
51	+35	+0.19	+0.75	- 7	-0.36	+0.05
52.5	+23			-10		
54	+23			-13		
56	+19			-20		
57.5	+19			-21		
59	+15			-27		
61	+ 9	+0.16	+0.61	-22	-0.38	+0.01
62.5	+11			-26		
64	+11			-25		
66	+ 2			-34		
67.5	+ 4			-32		
69	+ 4			-38		
71	+ 0	+0.06	+0.46	-38		
72.5	+ 4	+0.04	+0.44	-39	-0.33	-0.04
74	+ 5			-31		
76	+ 7			-28		
77.5	+ 7			-21		
79	+ 3			-23		

C109	N/S			E/W		
Depth Feet	Initial 7/18/64	DEFL 8/27/64	DEFL 6/4/65	Initial 7/14/64	DEFL 8/27/64	DEFL 6/4/65
81	+ 4	-0.02	+0.39	-18	-0.32	-0.01
82.5	+ 7			-17		
84	+ 7			-17		
86	- 1			-13		
87.5	0			-14		
89	+ 3			-17		
91	+ 1	-0.01	+0.34	- 9	-0.27	+0.02
92.5	+ 1			- 6		
94	+ 1			- 6		
96	+ 4			-30		
97.5	0			-28		
99	- 2			-28		
101	+ 10	-0.01	+0.33	-25	-0.16	+0.10
102.5	+10			-26		
104	+10			-28		
106	+ 7			-11		
107.5	+15			-20		
109	+ 7			-27		
111	+14	-0.08	+0.22	0	-0.17	+0.08
112.5	+17			0		
114	+19			0		
116	-10			- 9		
117.5	-14			- 9		
119	-14			- 9		
121	-6	-0.07	+0.19	-17	-0.14	+0.08
122.5	- 9			-19		
124	-10			-23		
126	-10			-17		
127.5	-11			-18		
129	-17			-20		
131	- 6	-0.06	+0.14	-23	-0.12	+0.08
132.5	- 8			-20		
134	- 6			-22		
136	+20			-12		
137.5	+20			-10		
139	+20			-11	-0.11	+0.09
141	+27	-0.03	+0.14	+16		
142.5	+29			+20		
144	+29	-0.04	+0.10	+25	-0.11	+0.06
146	+44			+47		
147.5	+40			+52		
149	+49	-0.04	+0.06	-52		
151	+71			-82	-0.10	+0.04
152.5	+69			+81		
154	+65			+83		
156	+44			+79		
157.5	+46			+79		

C109	N/S			E/W		
Depth Feet	Initial 7/18/64	DEFL 8/27/64	DEFL 6/4/65	Initial 7/14/64	DEFL 8/27/64	DEFL 6/4/65
159	+46			+79		
161	- 4	-0.06	+0.02	+49	-0.05	0
162.5	- 6			+46		
164	- 9			+38		
166	- 4			- 7		
167.5	- 2			- 7		
169	- 3			- 6		
171	-19	-0.03	-0.01	- 4	-0.01	+0.01
172.5	-23			- 4		
174	-34			- 4		
176	-93			+ 8		
177.5	-91			+10		
179	-93			+15		
181	-88			+59		
182.5	-84			+59		
184	-89			+59		

C130	N/S			E/W		
Depth Feet	Initial 7/20/64	DEFL 8/28/64	DEFL 6/14/65	Initial 7/20/64	DEFL 8/28/64	DEFL 6/14/65
4	212	+0.46	+0.36	119	+0.10	+0.41
6	217			118		
7.5	217			121		
9	218	+0.46	+0.40	119	+0.10	+0.36
11	170			141		
12.5	169			143		
14	169			142		
16	171			143		
17.5	173			145		
19	174	+0.37	+0.22	144	+0.08	+0.28
21	204			102		
22.5	192			101		
24	190			99		
26	190			100		
27.5	190			101		
29	189	+0.31	+0.26	104	+0.10	+0.19
31	183			109		
32.5	181			110		
34	180			111		
36	180			116		
37.5	185			117		
39	188	+0.21	+0.17	116	+0.14	+0.20
41	173			91		
42.5	173			89		
44	167			86		
46	173			84		
47.5	173			83		
49	178	+0.21	+0.16	84	+0.12	+0.10
51	187			124		
52.5	188			121		
54	183			121		
56	185			106		
57.5	180			103		
59	183	+0.16	+0.17	108	+0.18	+0.12
61	177			111		
62.5	175			110		
64	173			109		
66	174			109		
67.5	172			107		
69	174	+0.08	+0.15	106	+0.18	+0.04
71	187			104		
72.5	188			97	+0.18	+0.03
74	187			99		
76	188			98		
77.5	188			98		
79	187	+0.03	+0.12	98	+0.11	+0.03
81	165			98		

C130	N/S			E/W		
Depth Feet	Initial 7/20/64	DEFL 8/28/64	DEFL 6/14/65	Initial 7/20/64	DEFL 8/28/64	DEFL 6/14/65
82.5	162			98		
82.5	161			98		
84	161			93		
86	161			94		
87.5	158			93	+0.04	+0.04
89	159	+0.01	+0.04	92		
91	171			96		
92.5	168			94		
94	158			93		
96	172			89		
97.5	168			93		
99	165	+0.01	+0.02	97	0	+0.01

C134	N/S					
Depth Feet	Initial 7/10/64	DEFL 8/28/64	DEFL 6/14/65	DEFL 1979		
2						
4	+69					
6	+60	+0.02	+0.80	+0.08		
8	+60					
10	+60	-0.03	+0.66	+0.02		
12	+60					
14	+58					
16	+69					
18	+71					
20	+70	-0.05	+0.50	-0.14		
22	+68					
24	+71					
26	+79					
28	+81	0	+0.55			
30	+83	+0.02	+0.56	-0.11		
32	+83					
34	+83					
36	+75					
38	+74					
40	+75	-0.03	+0.46	-0.07		
42	+77					
44	+77					
46	+71					
48	+75					
50	+78	-0.04	+0.43			
52	+82					
54	+82					
56	+91					
58	+91					
60	+96					
62	+96					
64	+96					
66	+106					
68	+107					
70	+104	+0.05	+0.43			
72	+100	+0.03	+0.04			
74	+99					
76	+100					
78	+99					
80	+97	-0.04	+0.24			
82	+100					
84	+101					
86	+105					
88	+107					
90	+113	-0.08	+0.22			
92	+112					
94	+121					

C134 N/S

Depth Feet	Initial 7/10/64	DEFL 8/28/64	DEFL 6/14/65	DEFL 1979			
96	+129						
98	+123						
100	+121	-0.05	+0.22				
102	+118						
104	+118						
106	+116						
108	+114						
110	+116	-0.04	+0.15				
112	+114						
114	+109						
116	+ 90						
118	+ 92						
120	+ 87	+0.01	+0.11				
122	+ 84						
124	+ 84						
128	+ 92						
128	+ 91						
130	+ 91	+0.02	+0.09				
132	+ 91						
134	+ 89						
136	+ 95						
138	+ 98						
140	+ 98	+0.03	+0.10				
142	+ 99						
144	+101	+0.01	+0.07				
146	+ 97						
148	+101						
150	+107	0	+0.01				
152	+119						

C134 E/W							
Depth Feet	Initial 7/22/64	DEFL 8/28/64	DEFL 6/14/65	DEFL 1979			
2							
4							
6	143	0	+0.39	+0.07			
8	146						
10	151	+0.03	+0.44	-0.01			
12	155						
14	155						
16	147						
18	147						
20	146	+0.06	+0.48	-0.01			
22	145						
24	143						
26	153						
28	148						
30	143	+0.03	+0.44	+0.01			
32	142						
34	141						
36	140						
38	133						
40	131	-0.02	+0.34	+0.04			
42	136						
44	135						
46	142						
48	132						
50	140	-0.06	+0.25				
52	143						
54	141						
56	129						
58	130						
60	132	-0.09	+0.24				
62	130						
64	133						
66	123						
68	120						
70	120	-0.10	+0.20				
72	120	-0.10	+0.19				
74	123						
76	128						
78	127						
80	127	-0.09	+0.20				
82	127						
84	133						
86	133						
88	133						
90	134	-0.06	+0.20				
92	135						
94	131						

C134 E/W							
Depth Feet	Initial 7/22/64	DEFL 8/28/64	DEFL 6/14/65	DEFL 1979			
96	131						
98	128						
100	126	-0.06	+0.19				
102	127						
104	126						
106	126						
108	128						
110	129	-0.05	+0.12				
112	122						
114	122						
116	118						
118	117						
120	109	-0.08	+0.03				
122	109						
124	99						
126	99						
128	99						
130	99	-0.10	-0.02				
132	93						
134	86						
136	97						
138	94						
140	90	-0.05	-0.04				
142	92						
144	89						
148	+82						
150	+88	-0.02	-0.02				
152							

CB5	N/S			E/W			
Depth Feet	Initial 10/15/79	Initial 1/27/81	DEFL 1981	Initial 10/15/79	Initial 1/27/81	DEFL 1981	
2	536	460	-0.110	-1083	-569	-0.133	
4	488	466		-1038	-541		
6	551	498		- 390	-614		
8	449	509		- 326	-595		
10	332	462	-0.055	- 290	-574	-0.384	
12	317	433		- 257	-535		
14	294	438		- 242	-489		
16	395	397		- 195	-250		
18	489	364		- 202	-213		
20	461	358	-0.215	- 203	-168	+0.014	
22	379	337		- 145	- 81		
24	400	327		- 59	14		
26	287	200		182	254		
28	157	188		190	224		
30	119	144	-0.051	215	216	-0.022	
32	94	115		244	225		
34	69	82		281	274		
36	66	-17		367	415		
38	47	-26		323	386		
40	21	-39	-0.007	340	406	-0.074	
42	2	-43		373	433		
44	-3	-36		382	434		
46	24	46		615	656		
48	22	60		657	634		
50	64	113	+0.054	704	598	-0.191	
52	131	168	+0.025	709	578	-0.122	
54	206	210	+0.002	655	583	-0.043	
56		395			435		
58		452			441		
60		416			439		
62		415			431		
64		292			429		
66		451			436		
68		642			484		

Appendix C

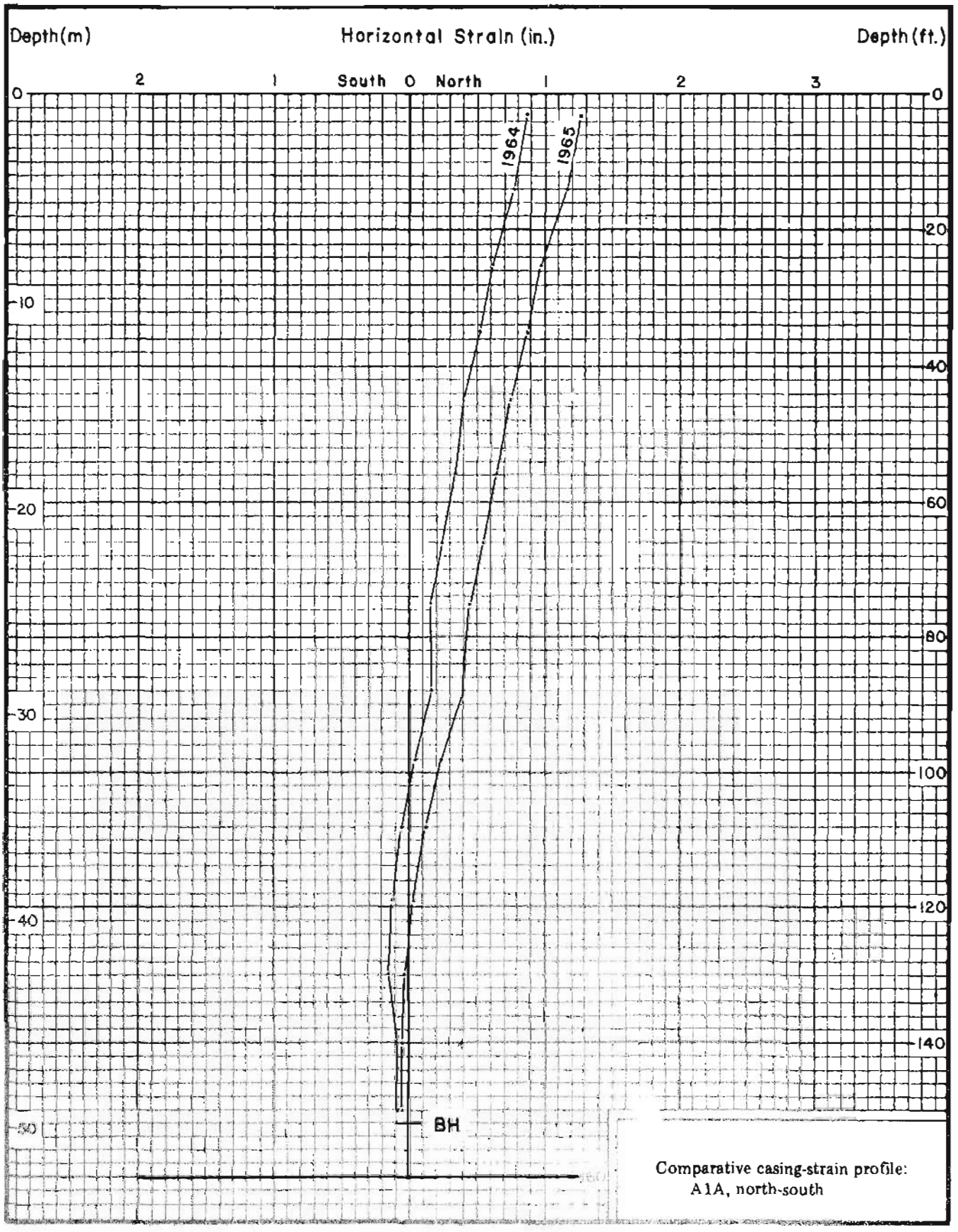
COMPARATIVE CASING-STRAIN PROFILES

Appendix C presents a comparison of the apparent changes in the casing profiles that occurred since the initial calibration readings made in 1964.

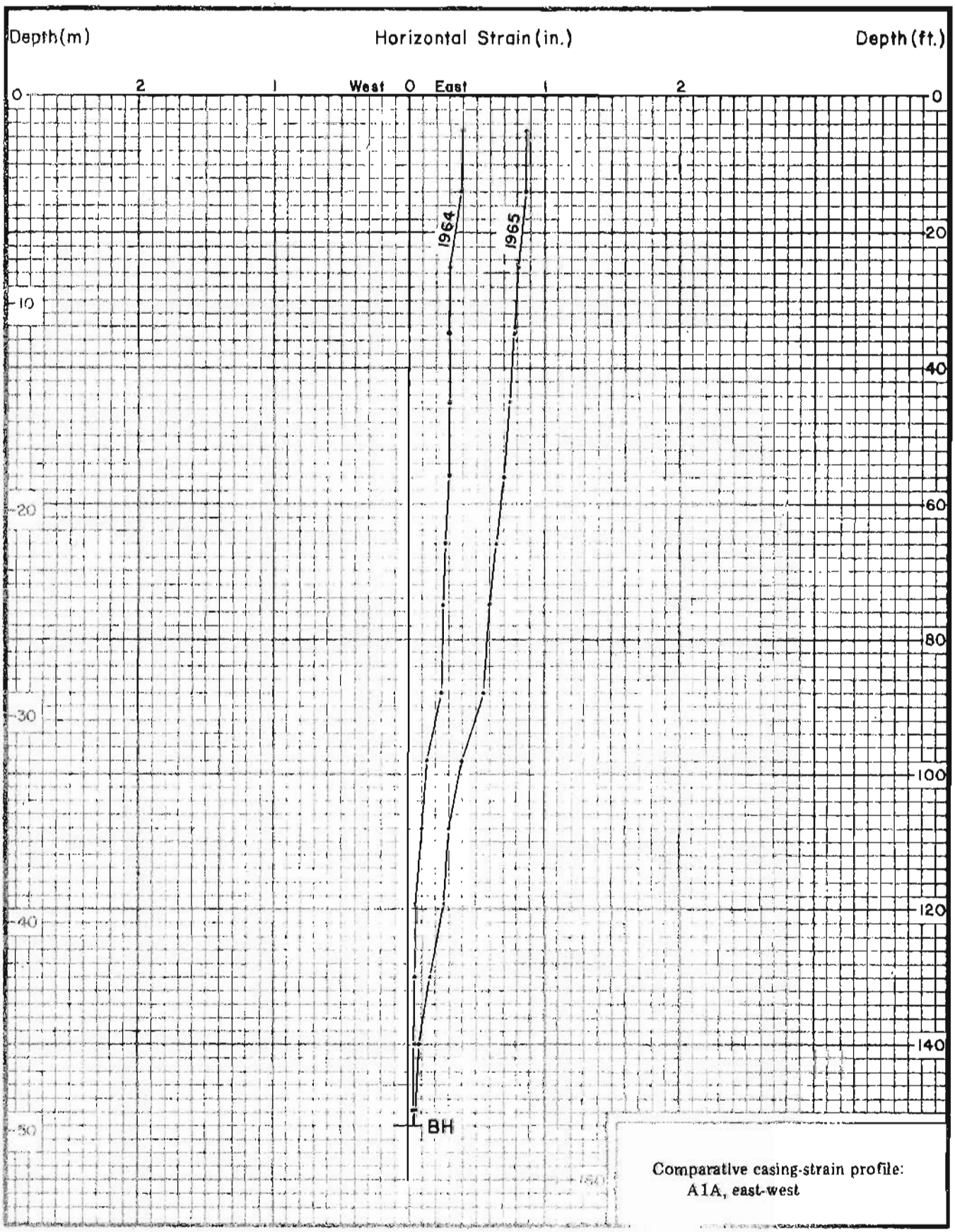
The initial profile is plotted as a straight vertical line, indicated by the 0, or zero point. The curves represent the deflection from the initial point for successive depths.

The year in which the readings were obtained is indicated on each curve. Usually, an inclinometer survey was made a few months after the initial survey readings and is indicated as '1964'. However, many casings were buried or destroyed in 1964-1965, and no further readings were obtained. Casings A112S and A1005S were installed in 1977, which accounts for their brief history.

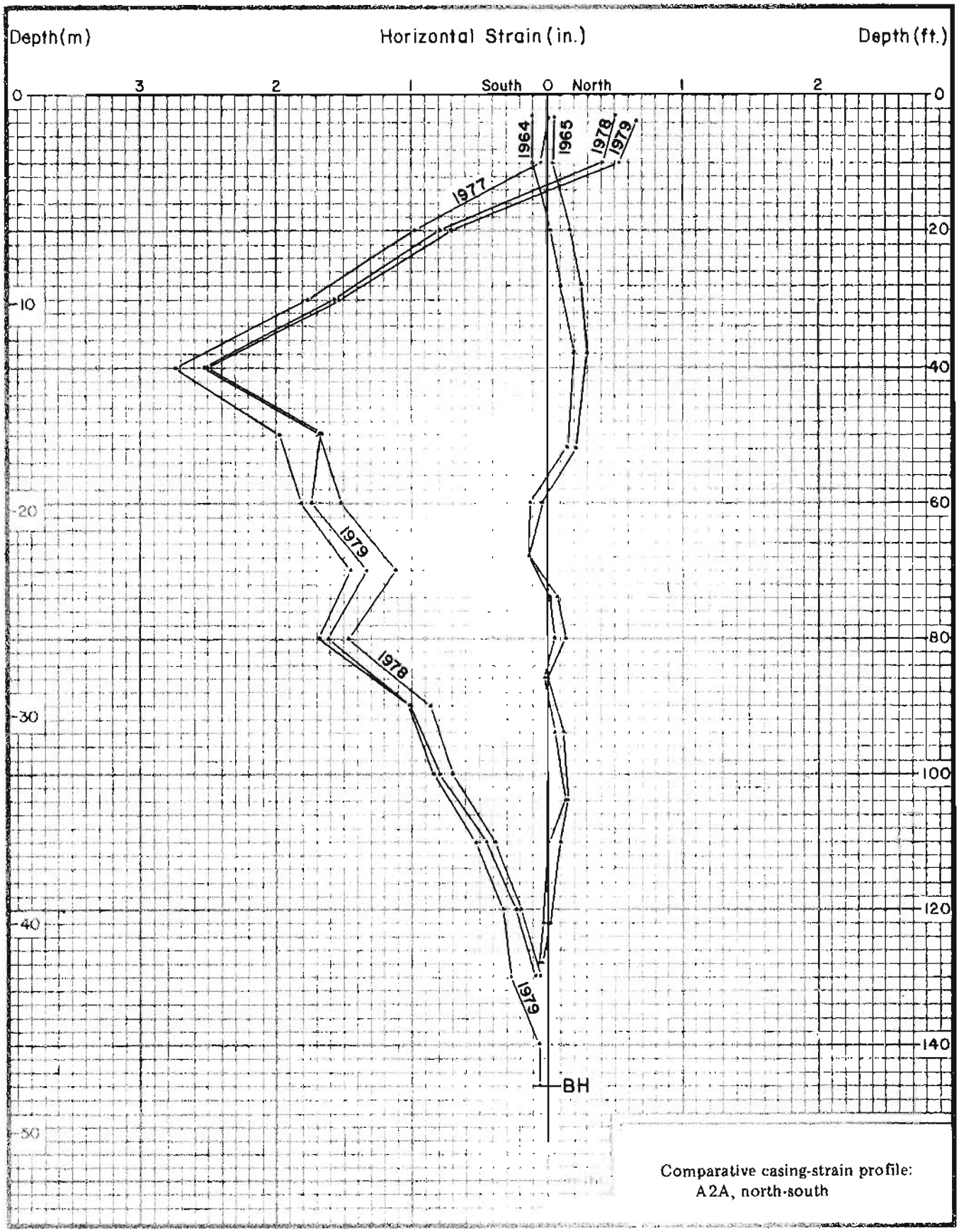
The horizontal variance (strain) with respect to depth is given in inches from the initial zero condition. BH is base of the hole.



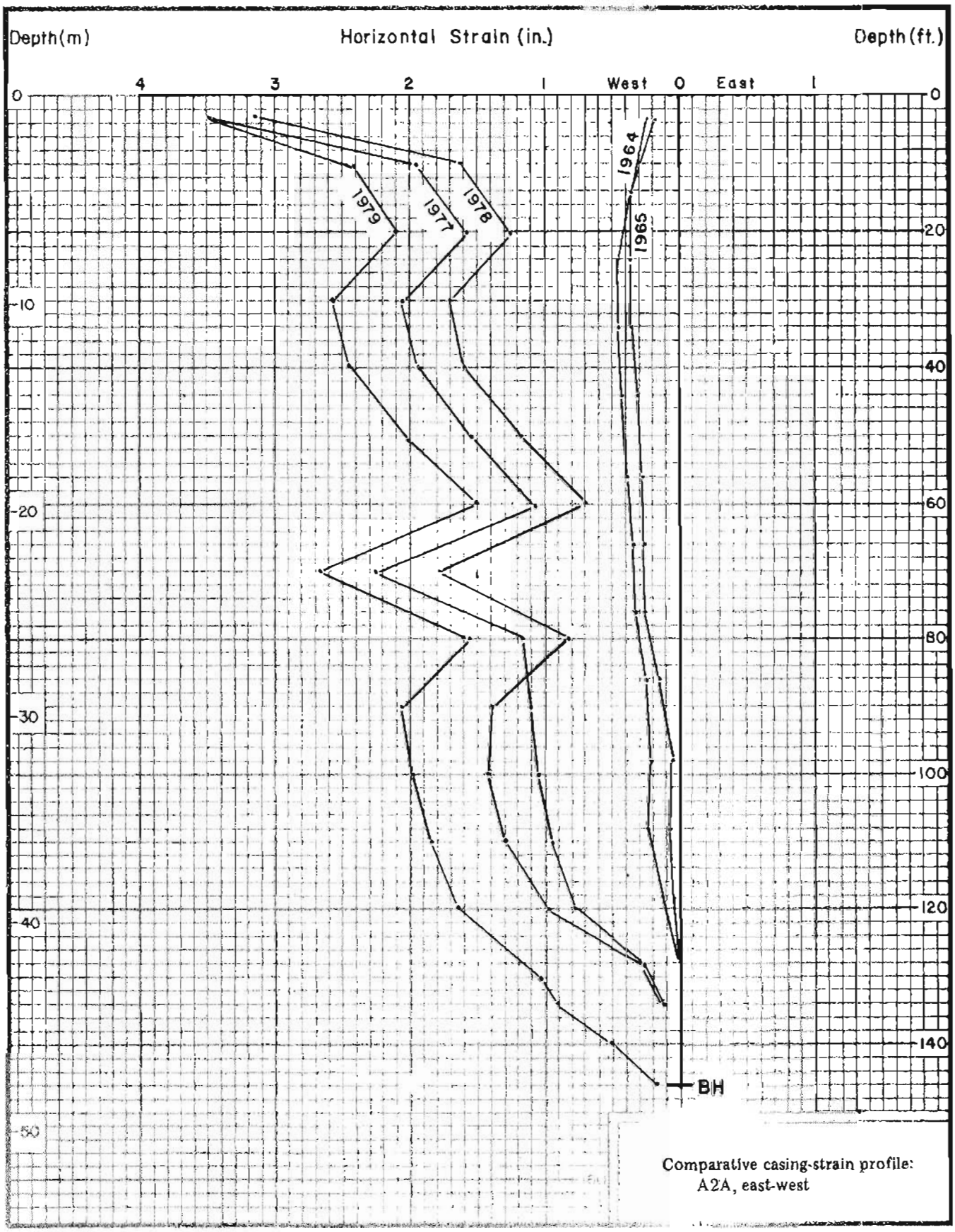
Comparative casing-strain profile: A1A, north-south



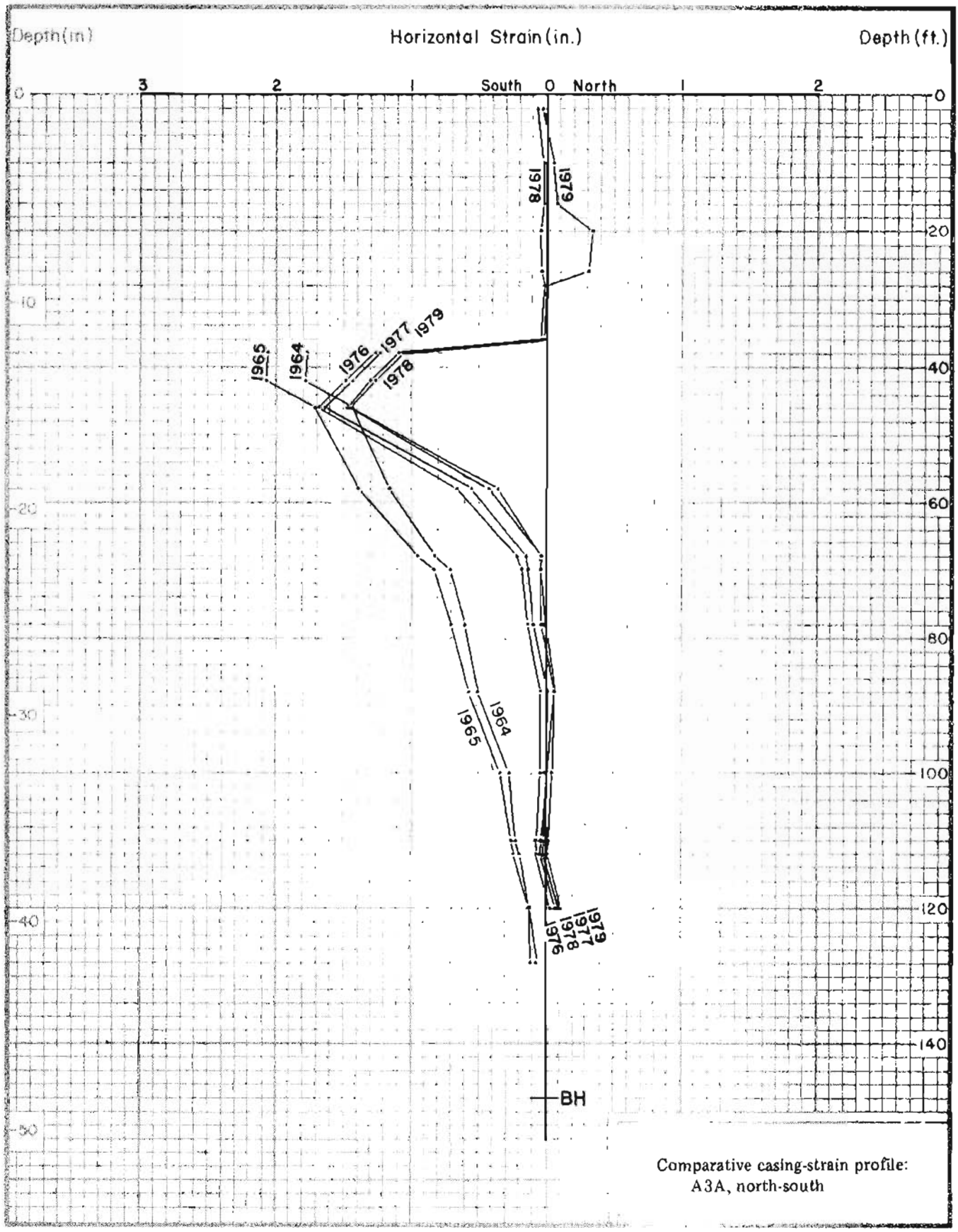
Comparative casing-strain profile:
A1A, east-west



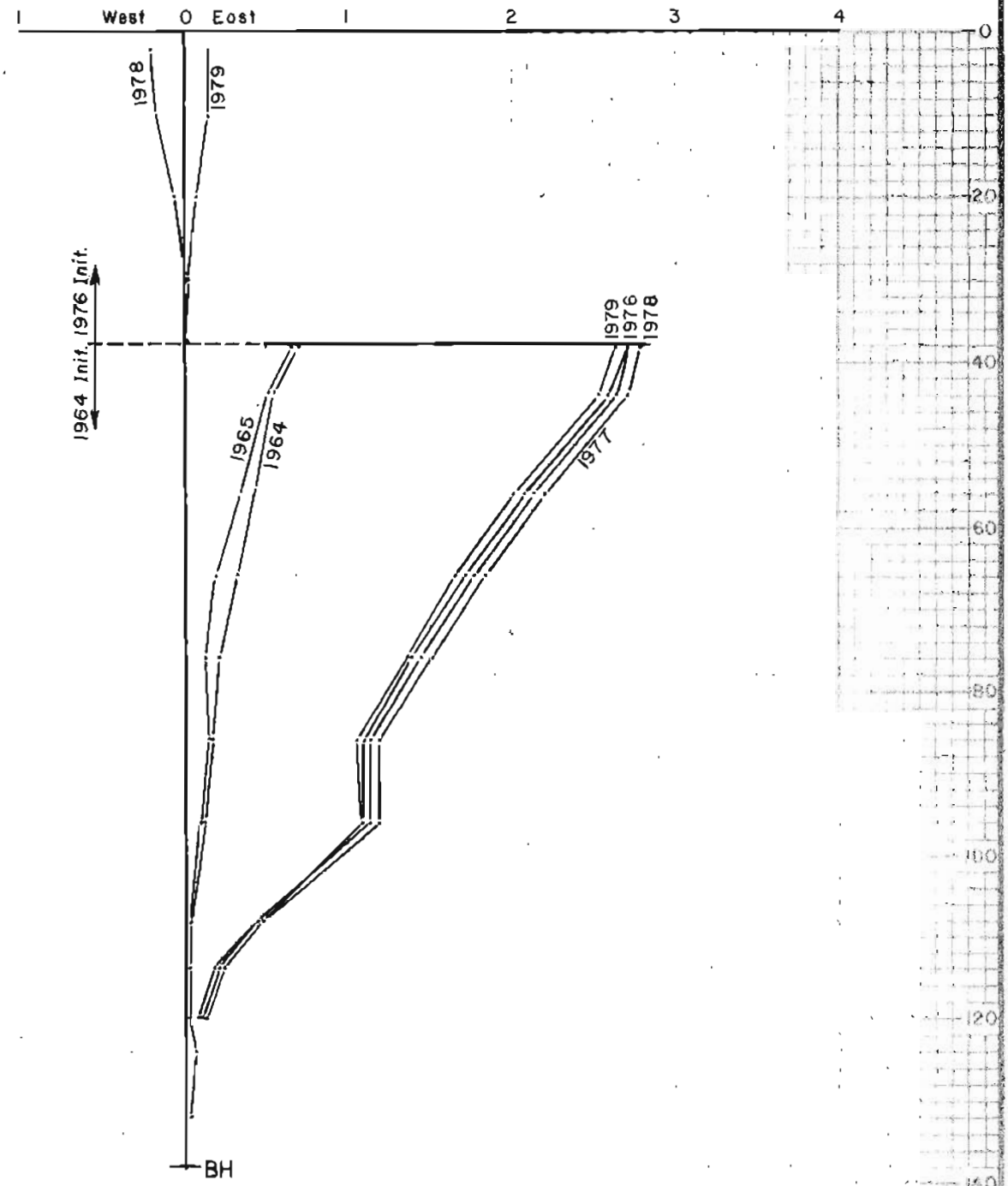
Comparative casing-strain profile: A2A, north-south



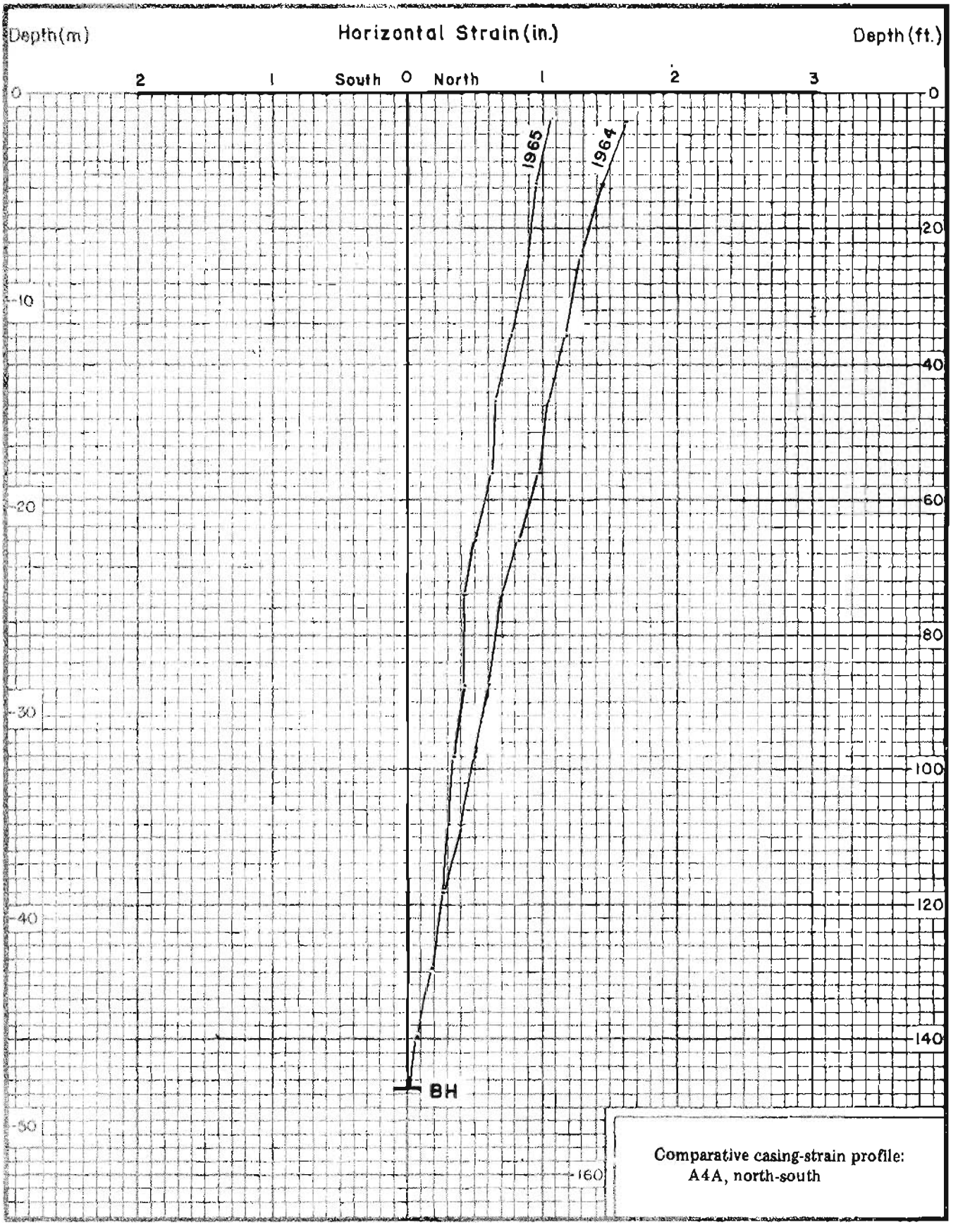
Comparative casing-strain profile: A2A, east-west



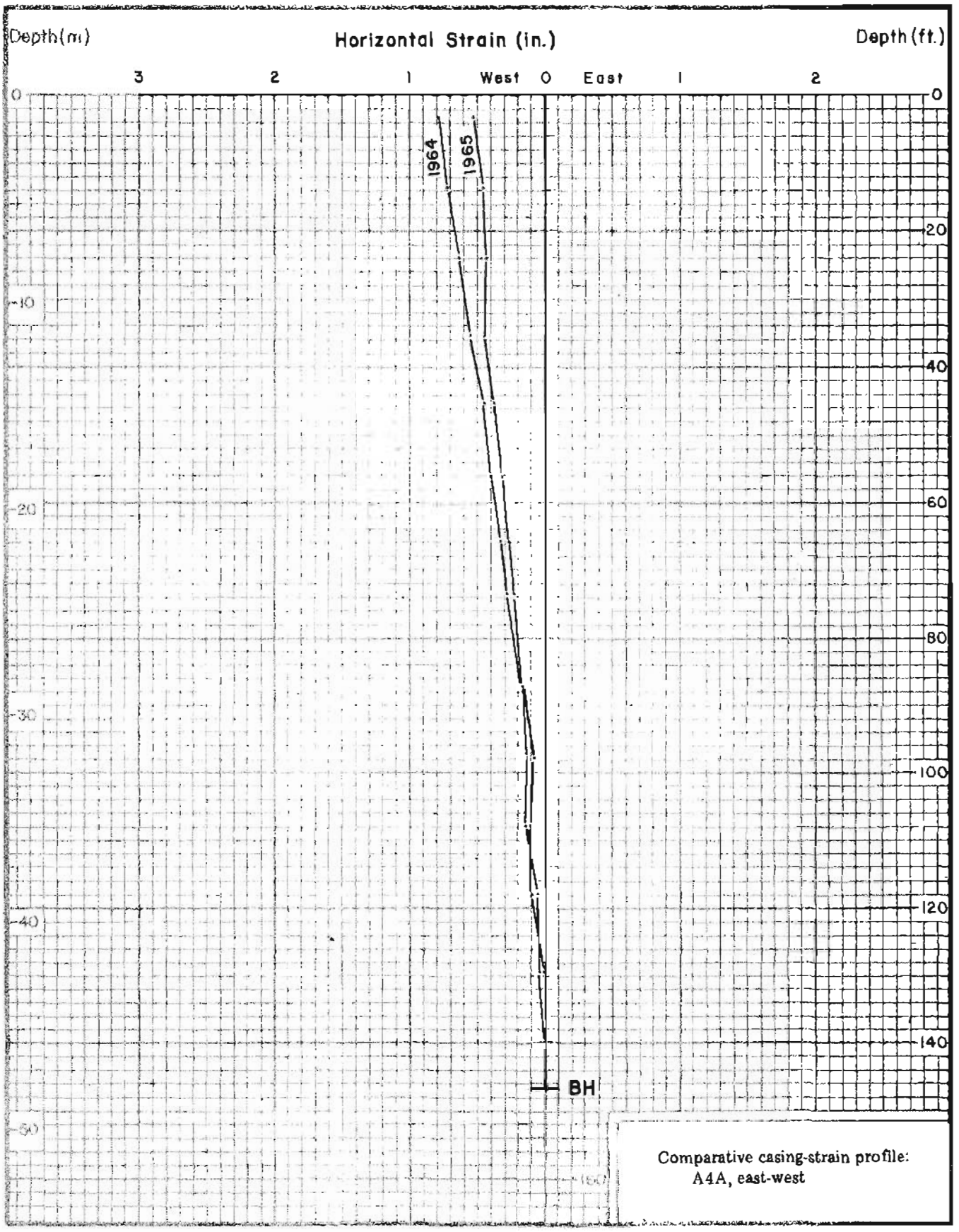
Comparative casing-strain profile:
A3A, north-south



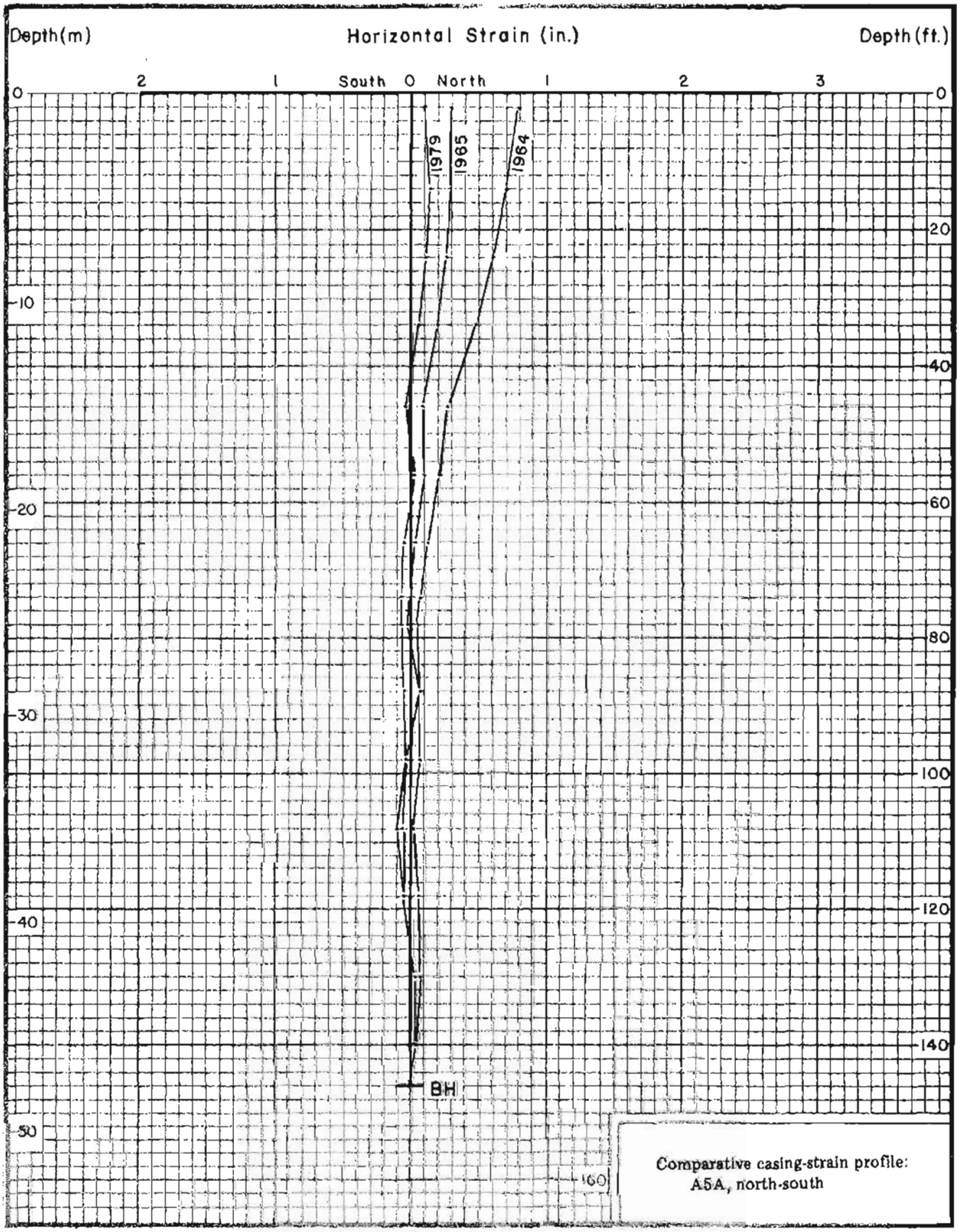
Comparative casing-strain profile: A3A, east-west



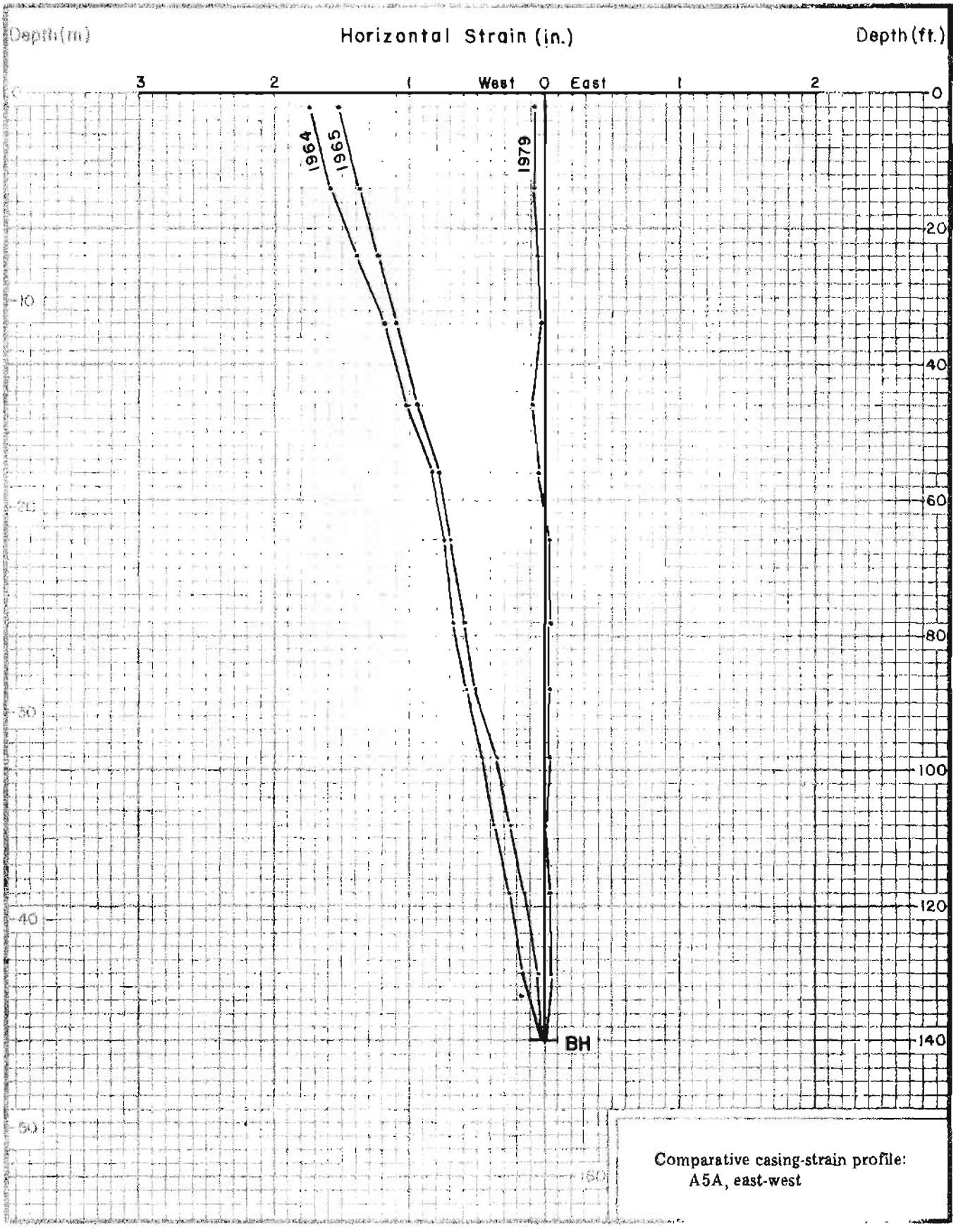
Comparative casing-strain profile:
A4A, north-south



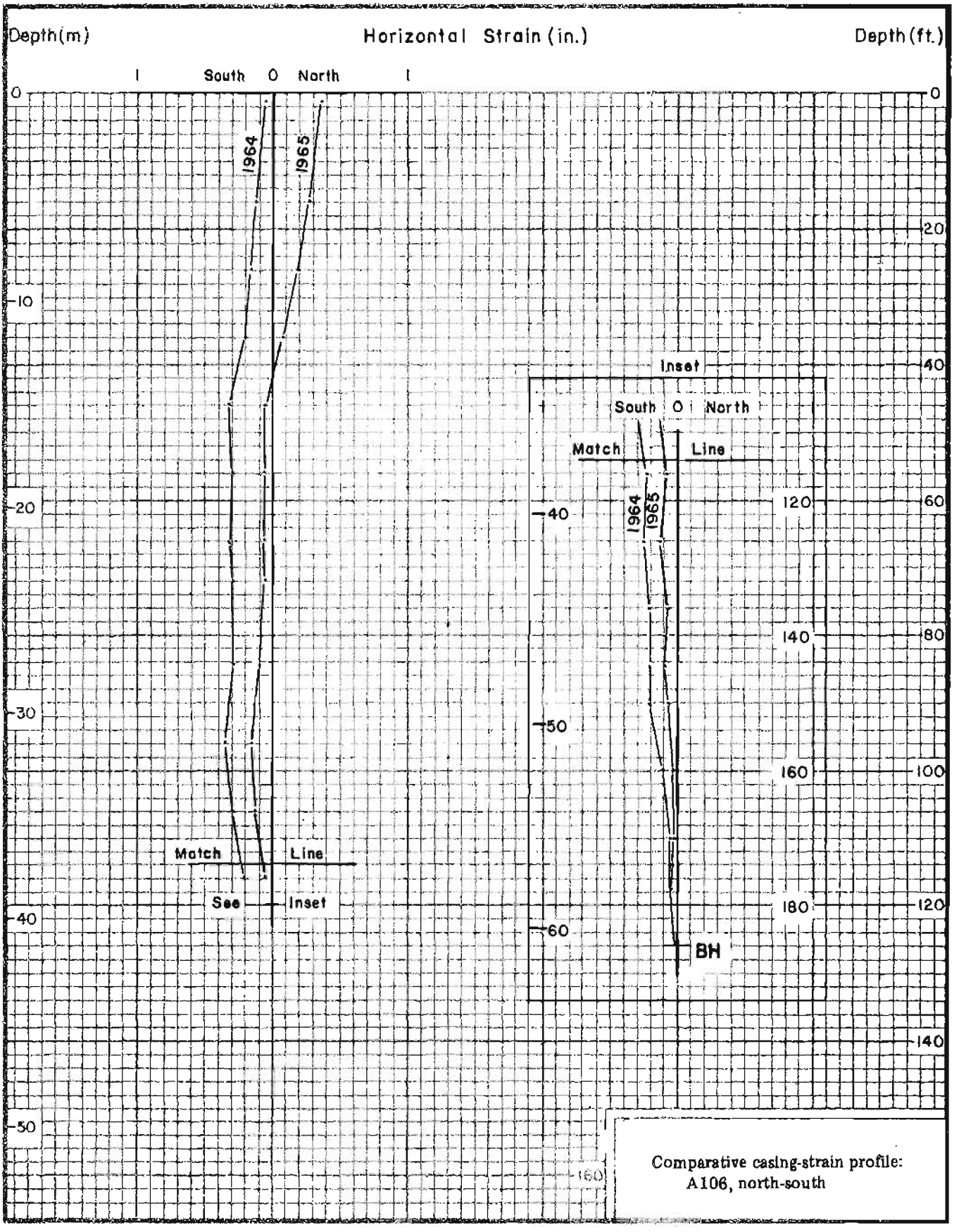
Comparative casing-strain profile:
A4A, east-west



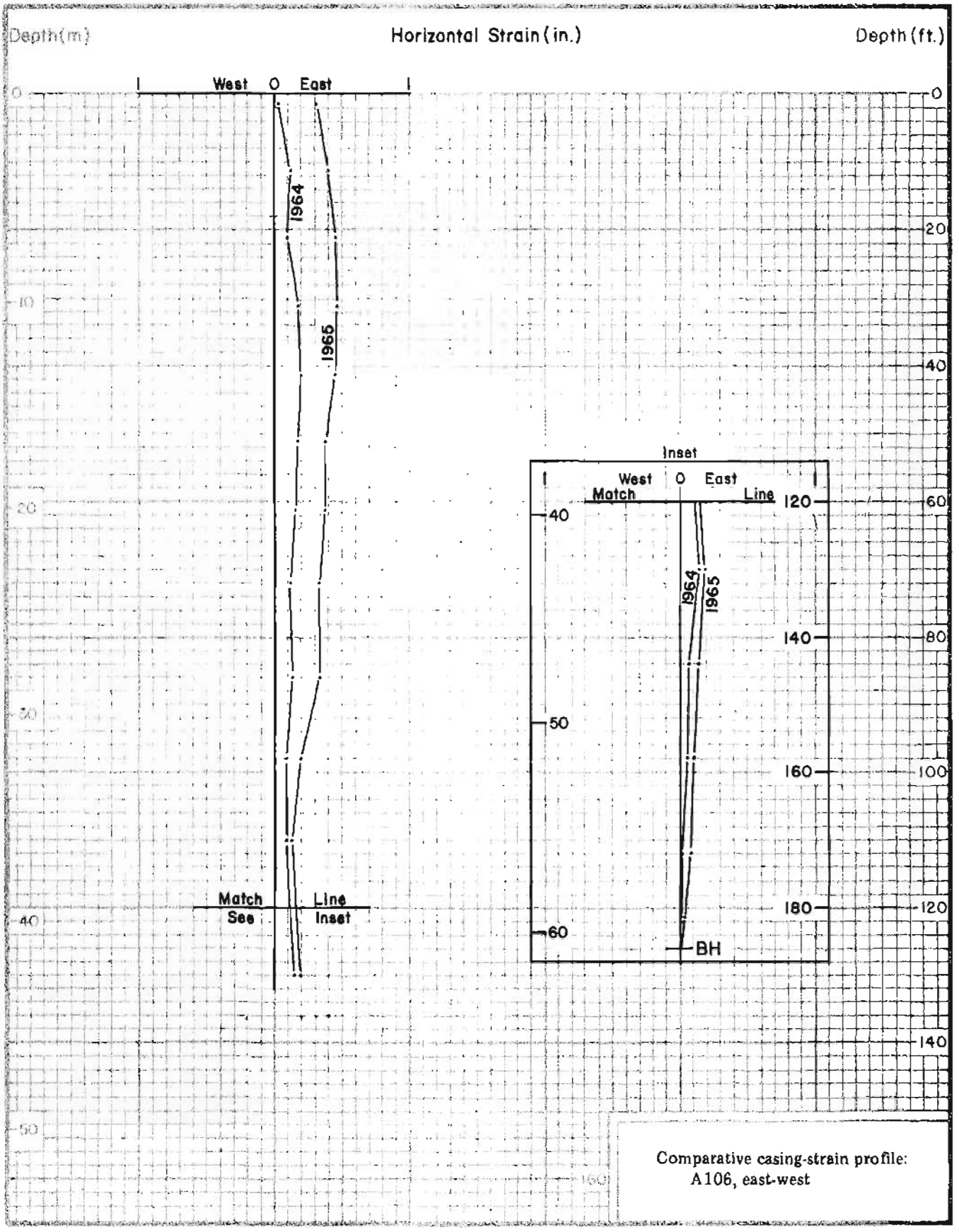
Comparative casing-strain profile: A5A, north-south



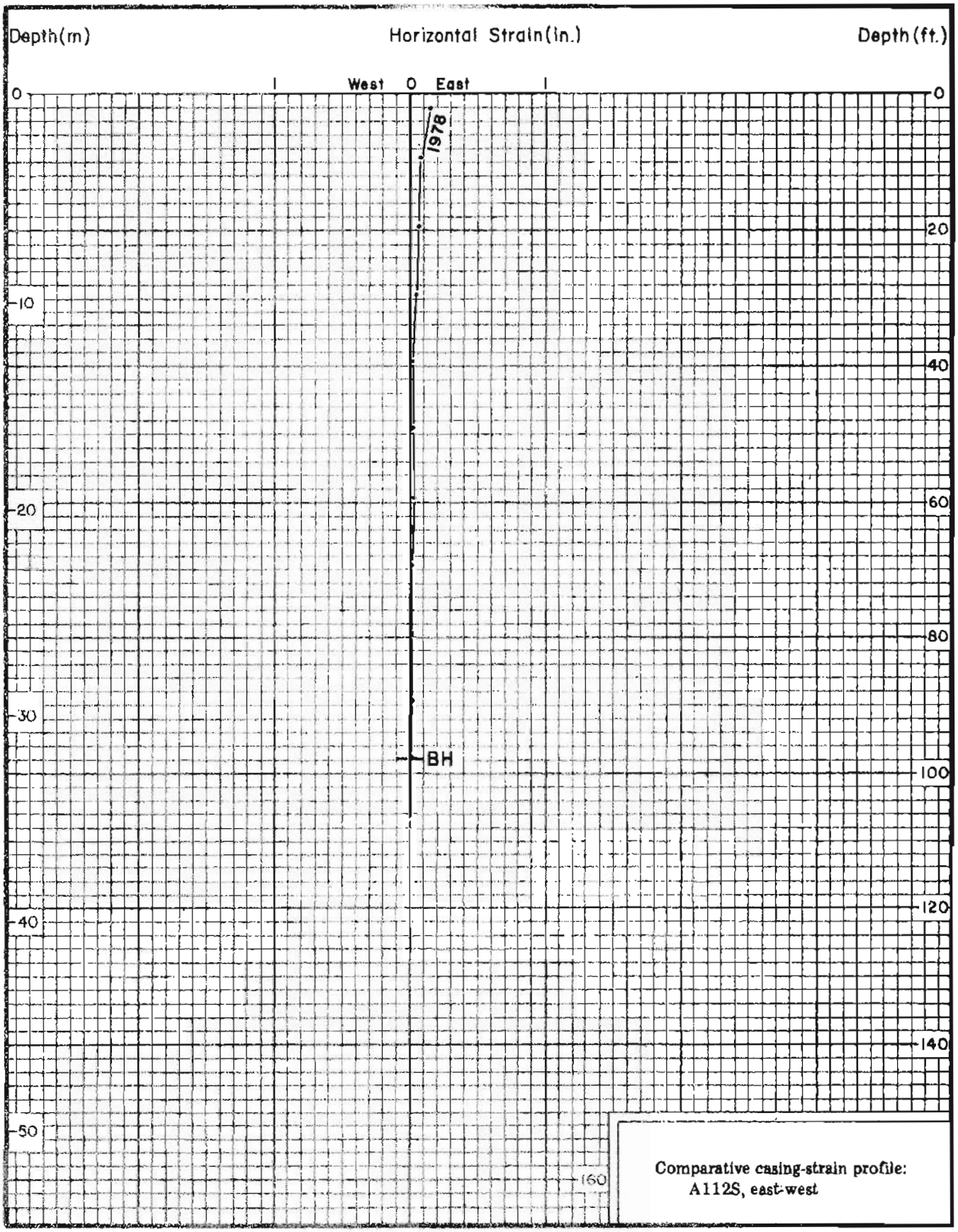
Comparative casing-strain profile:
A5A, east-west



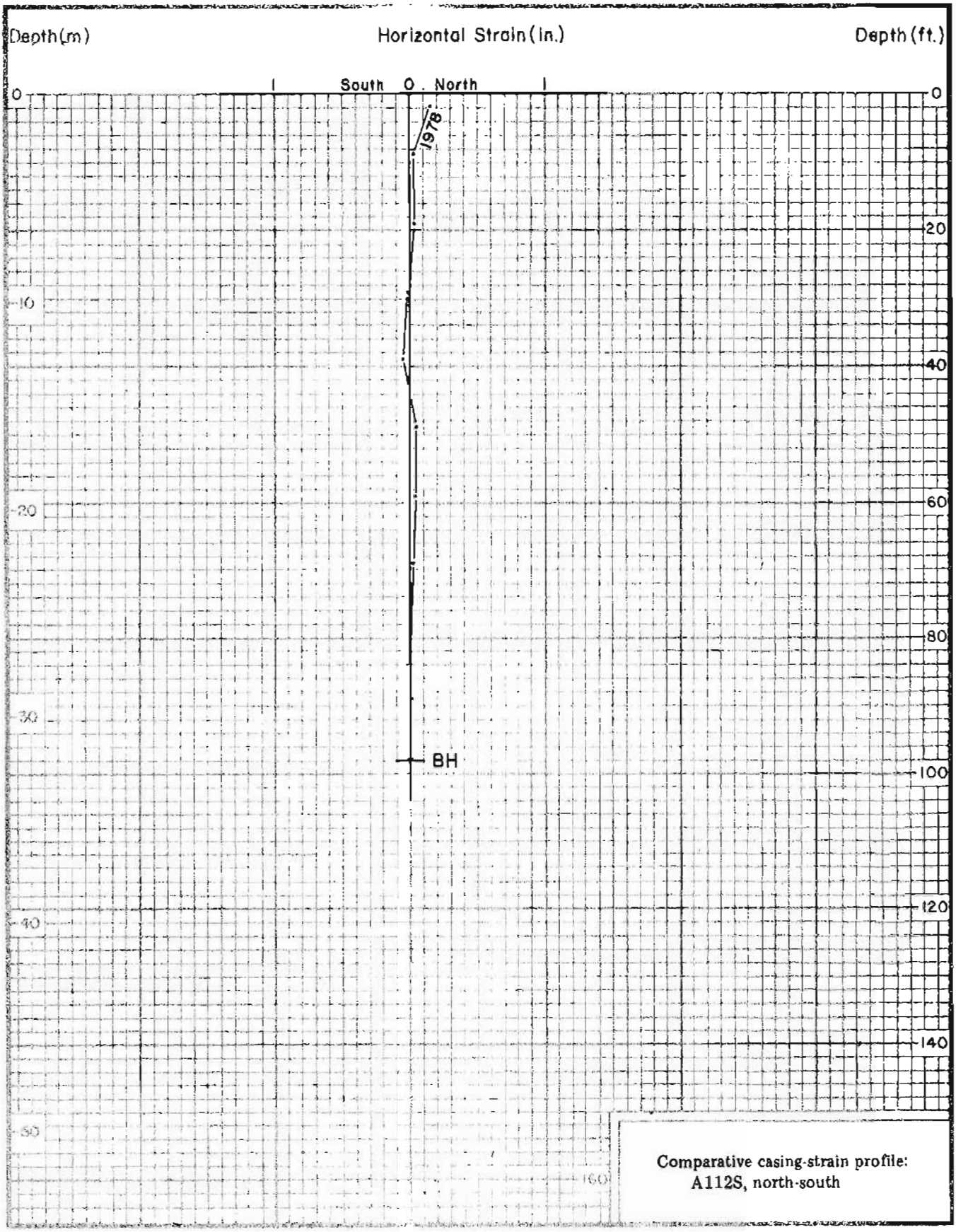
Comparative casing-strain profile: A106, north-south



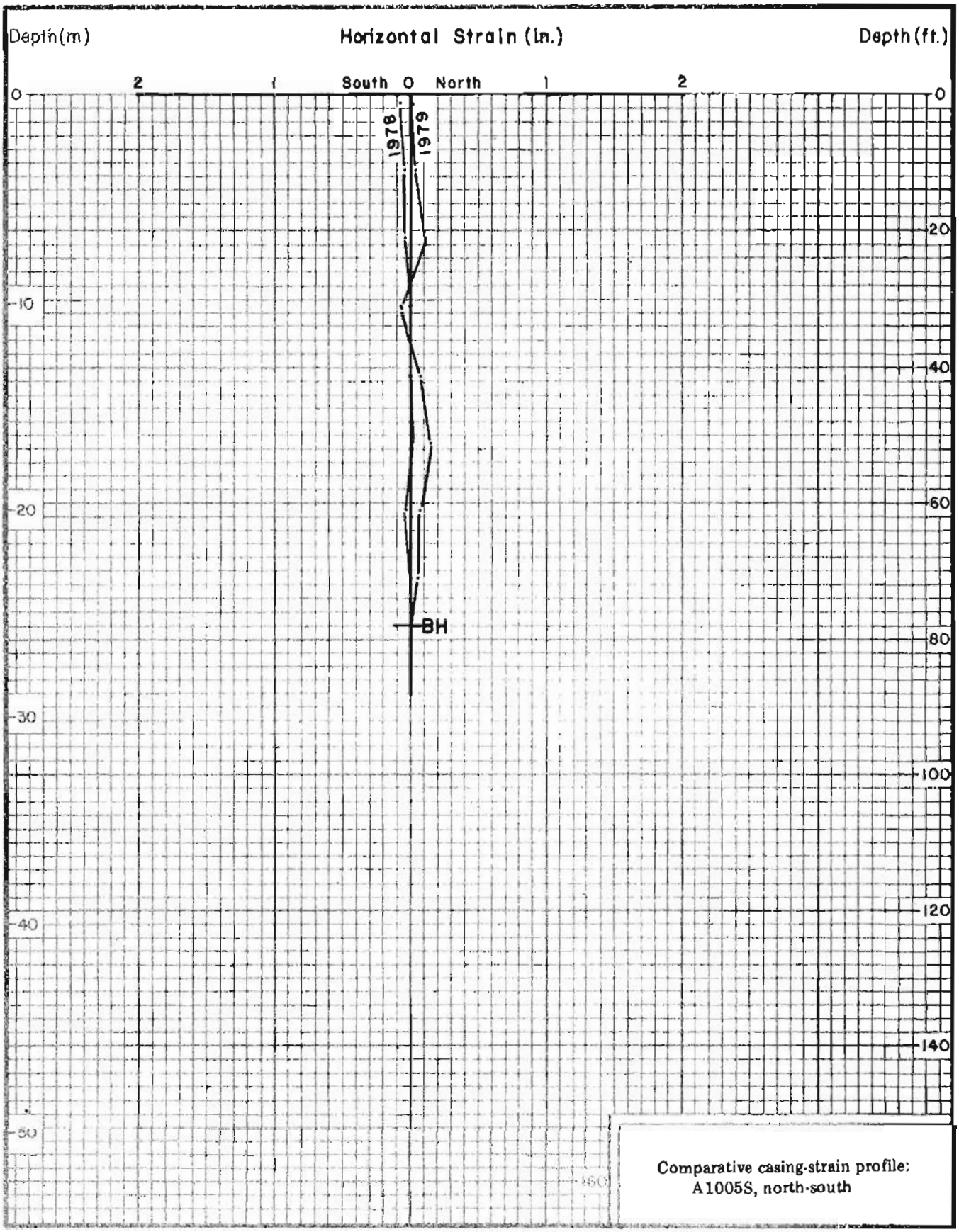
Comparative casing-strain profile:
A106, east-west



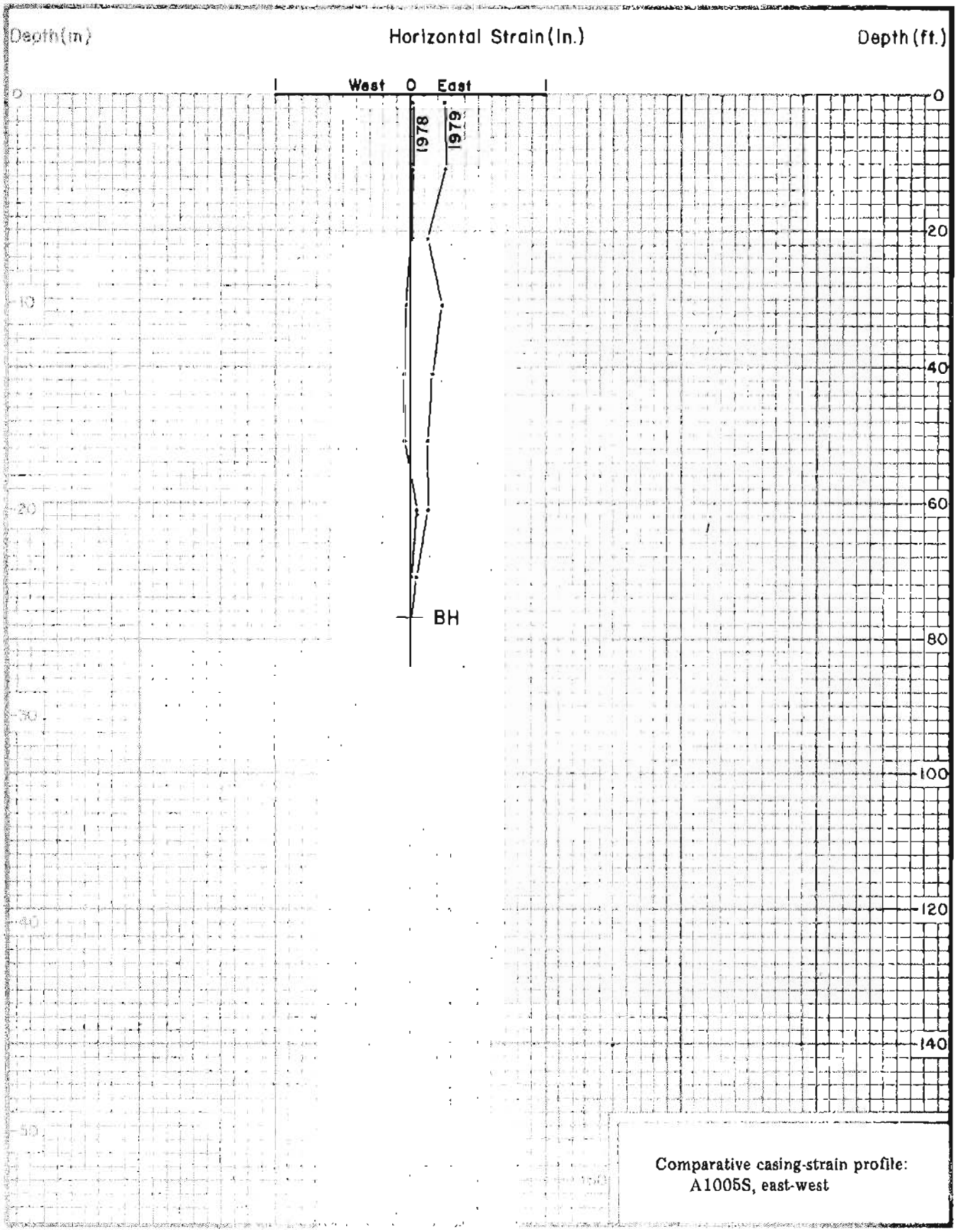
Comparative casing-strain profile: A112S, east-west



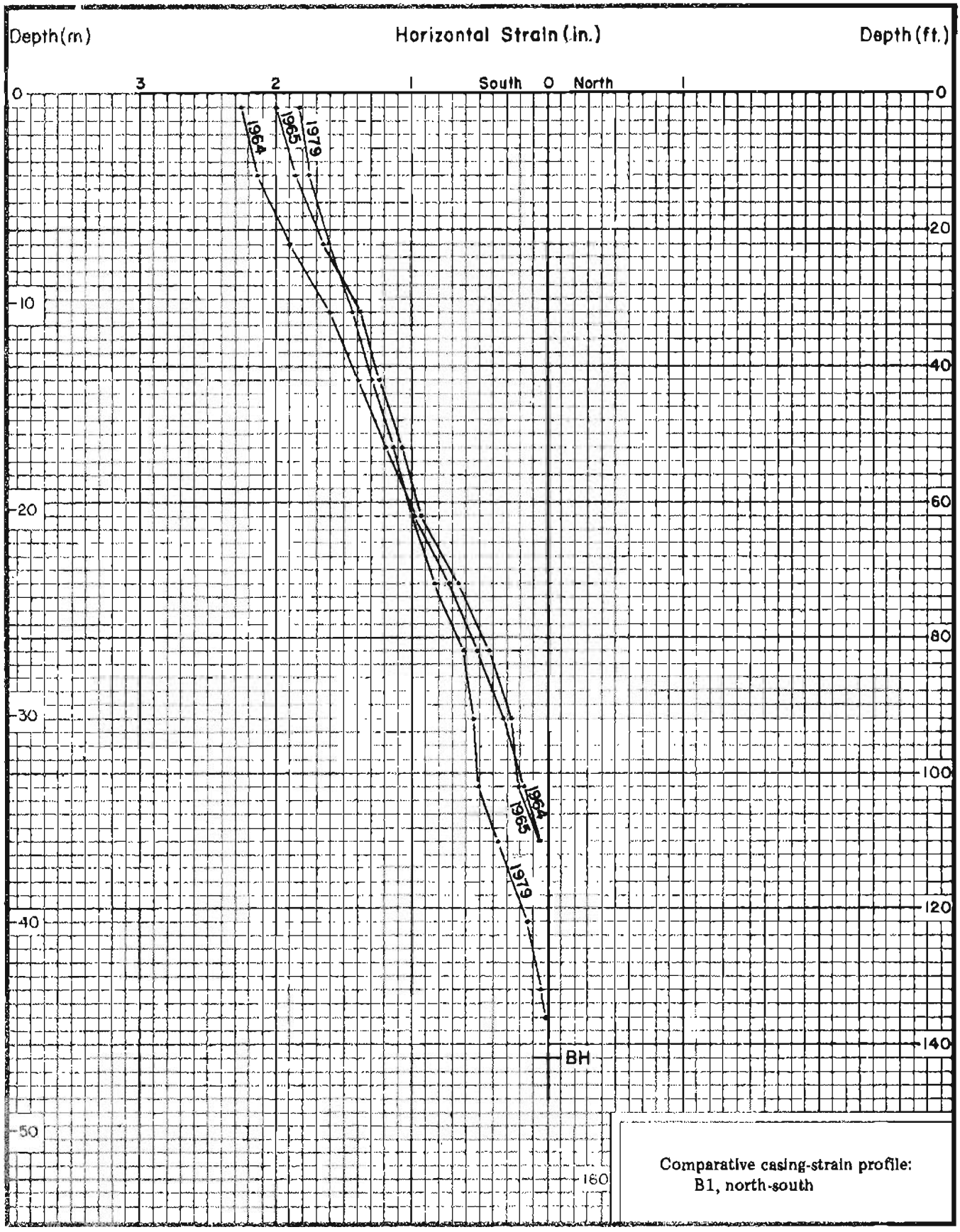
Comparative casing-strain profile:
A112S, north-south



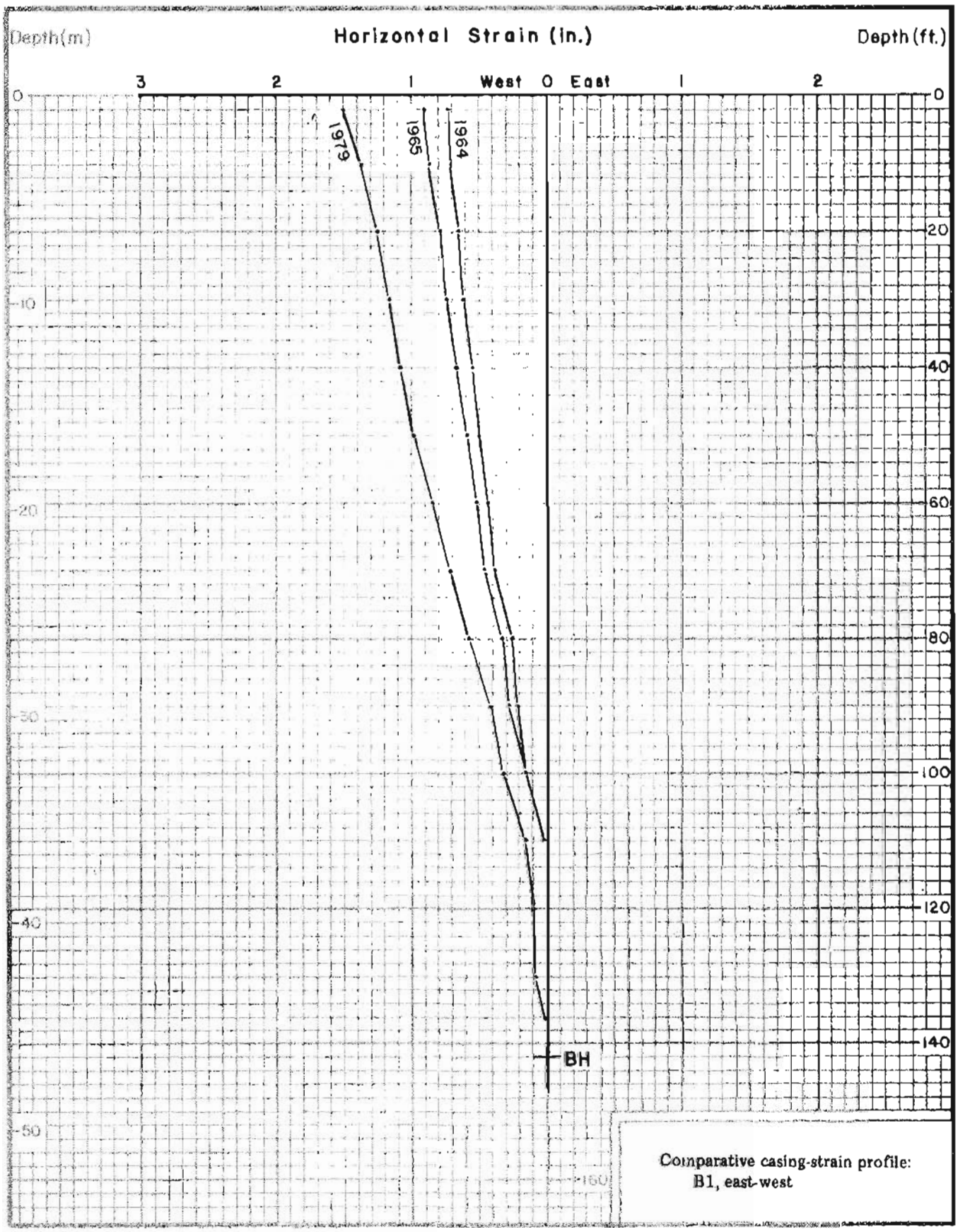
Comparative casing-strain profile: A1005S, north-south



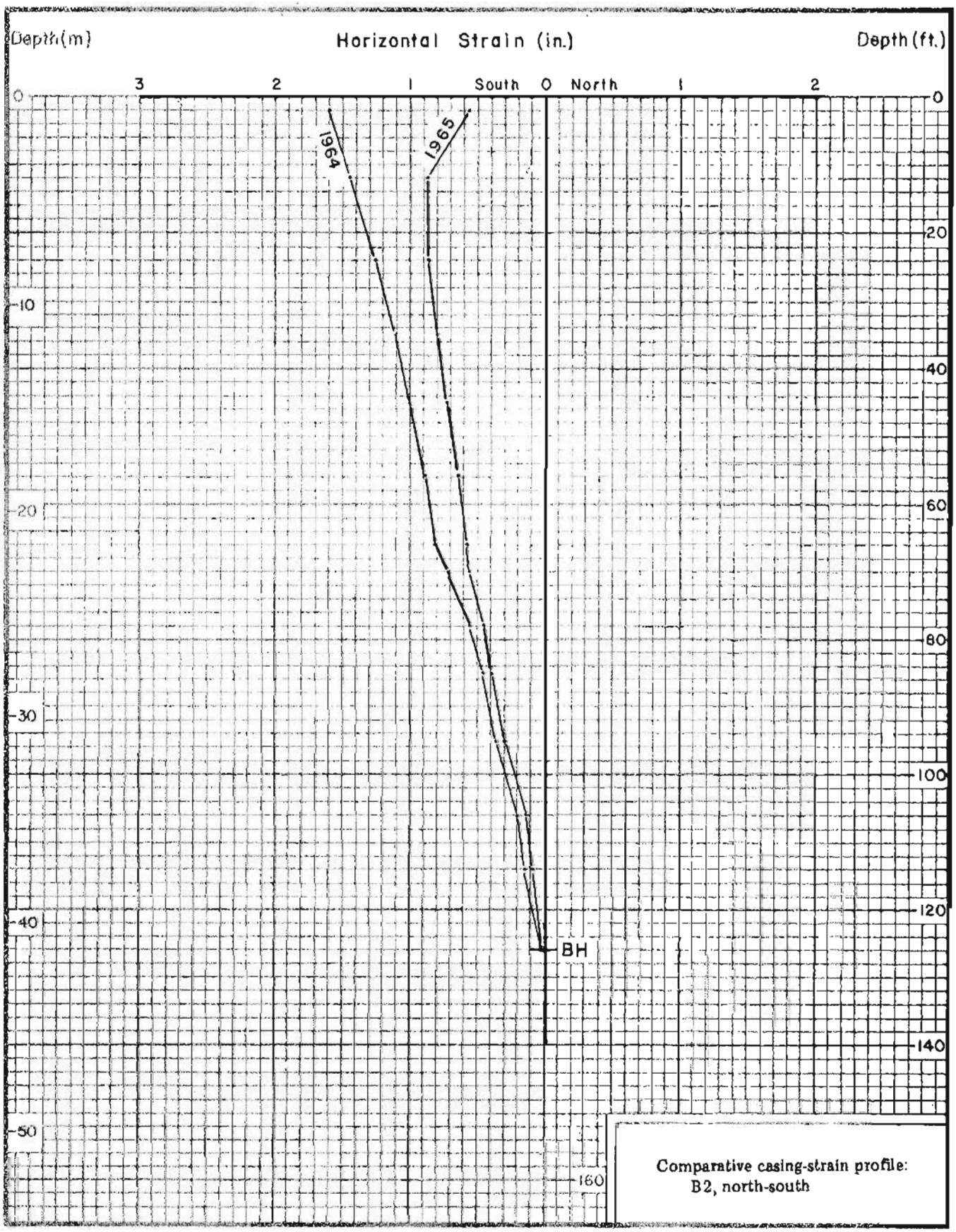
Comparative casing-strain profile:
A1005S, east-west



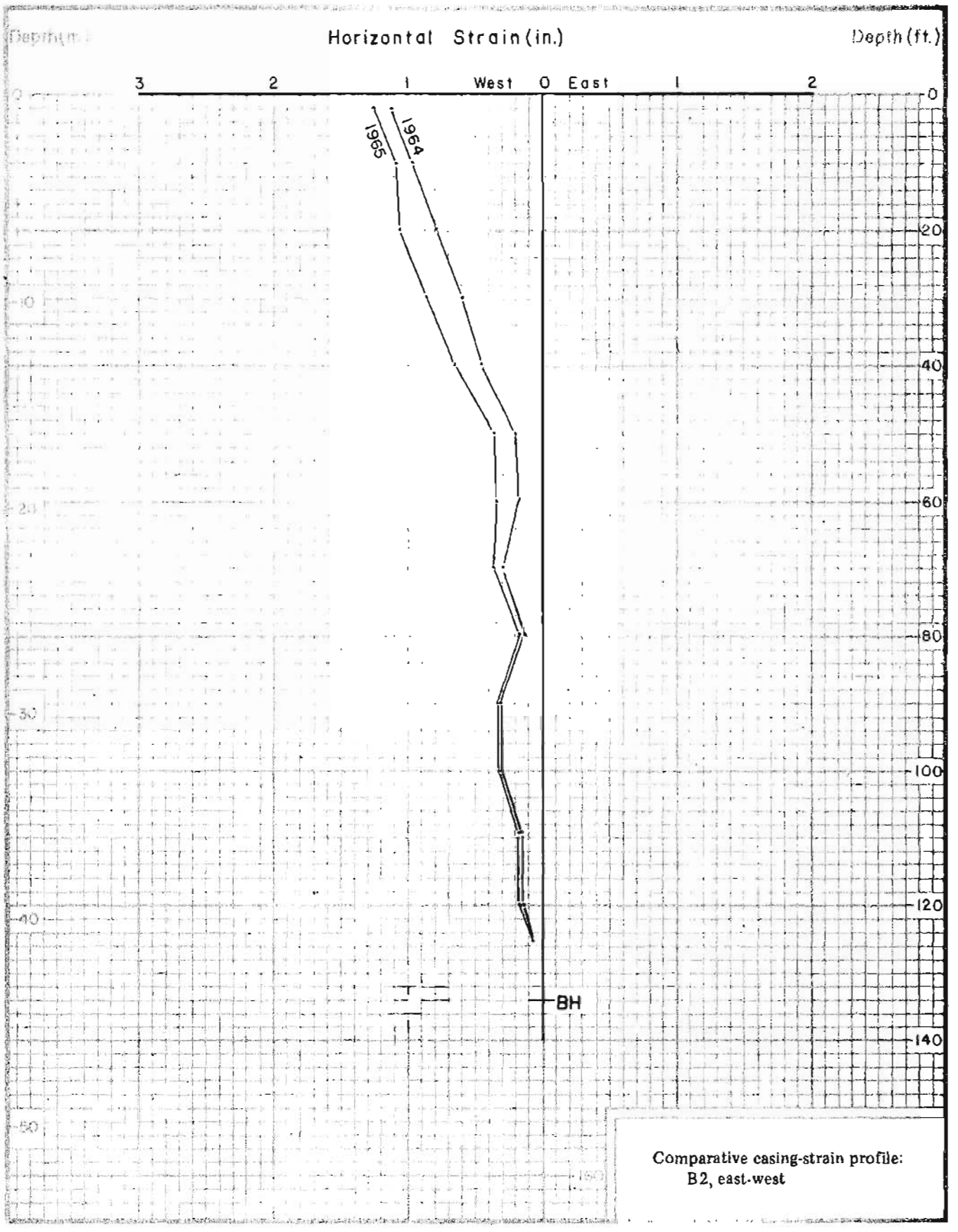
Comparative casing-strain profile:
B1, north-south



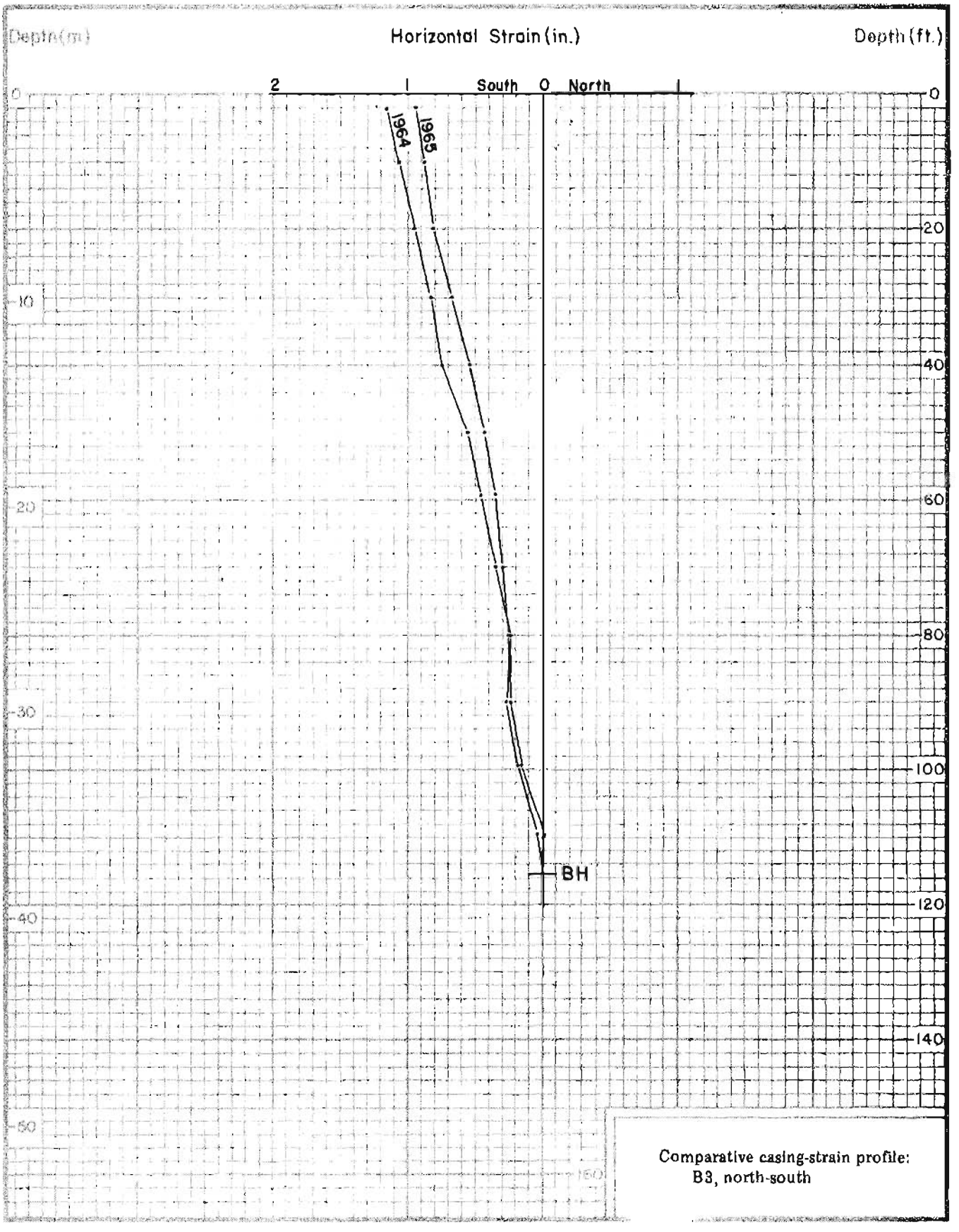
Comparative casing-strain profile:
B1, east-west



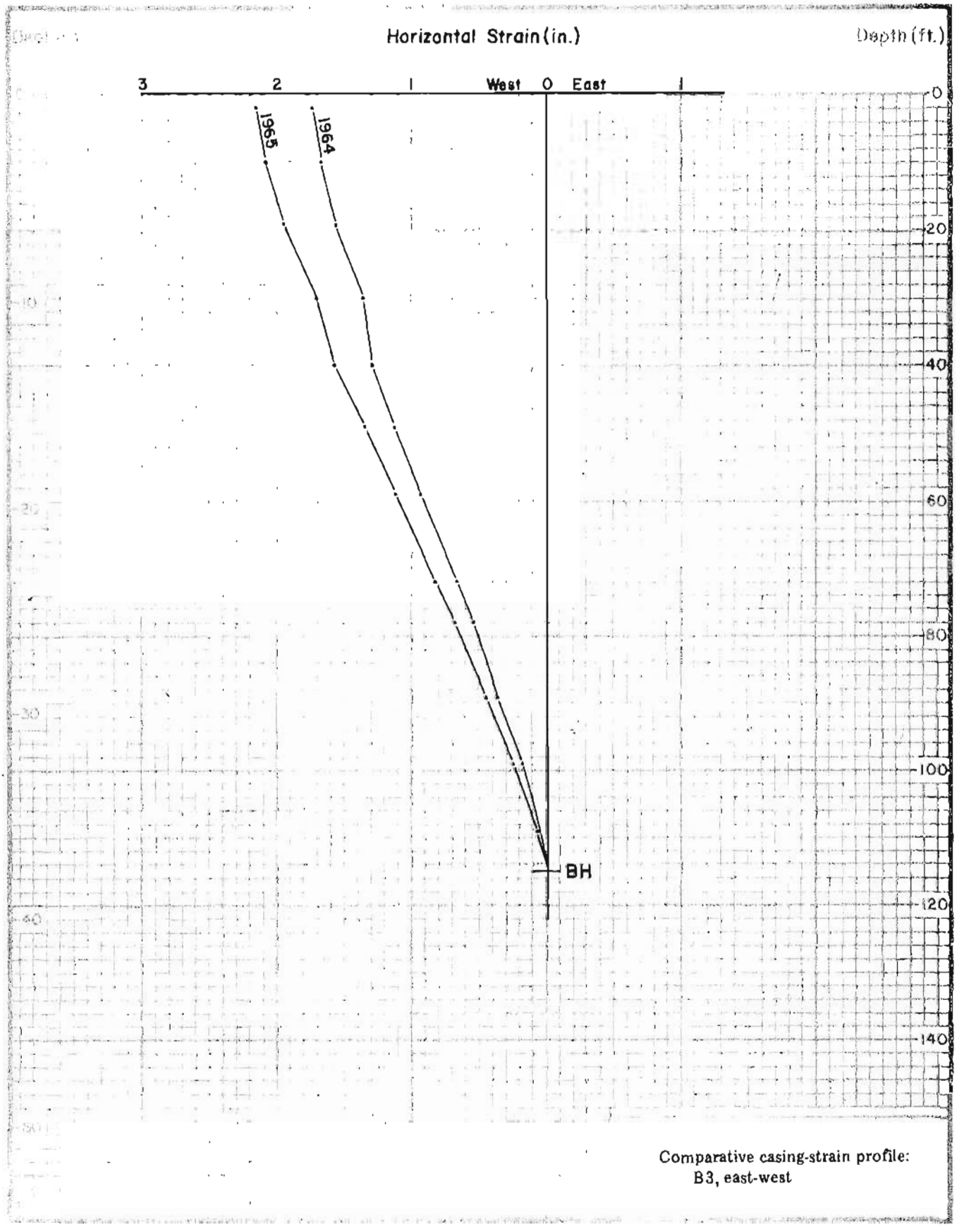
Comparative casing-strain profile:
B2, north-south



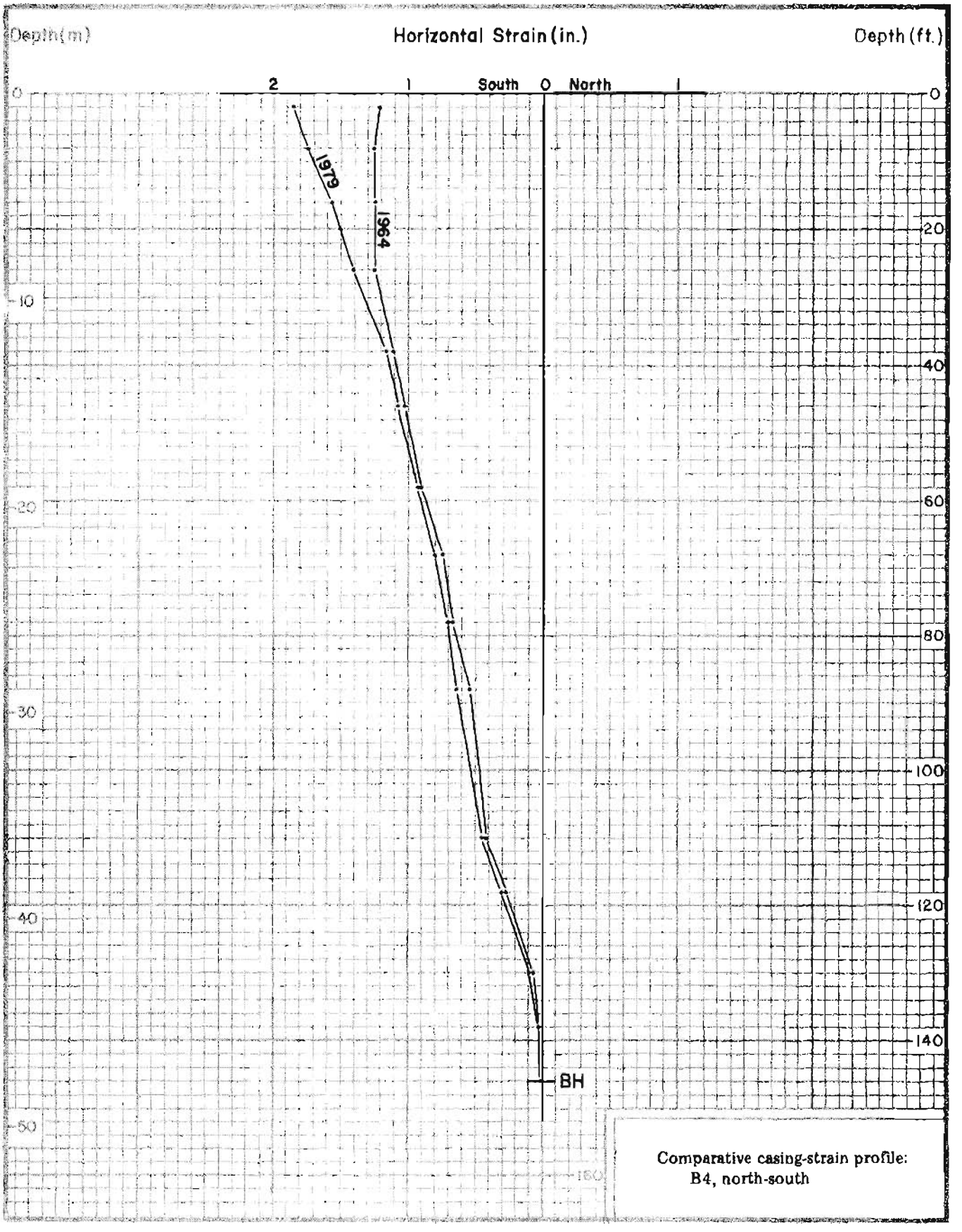
Comparative casing-strain profile:
B2, east-west



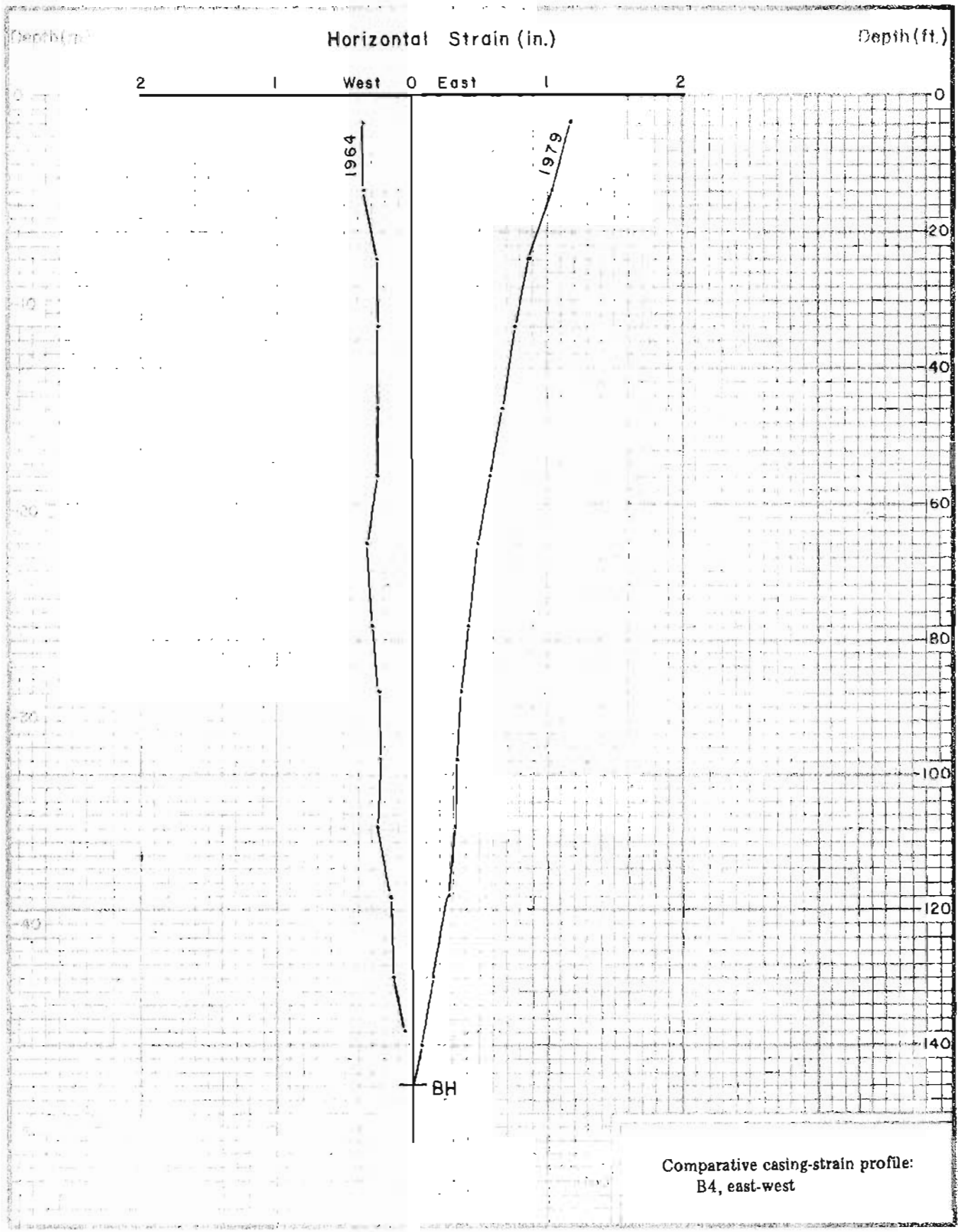
Comparative casing-strain profile:
B3, north-south



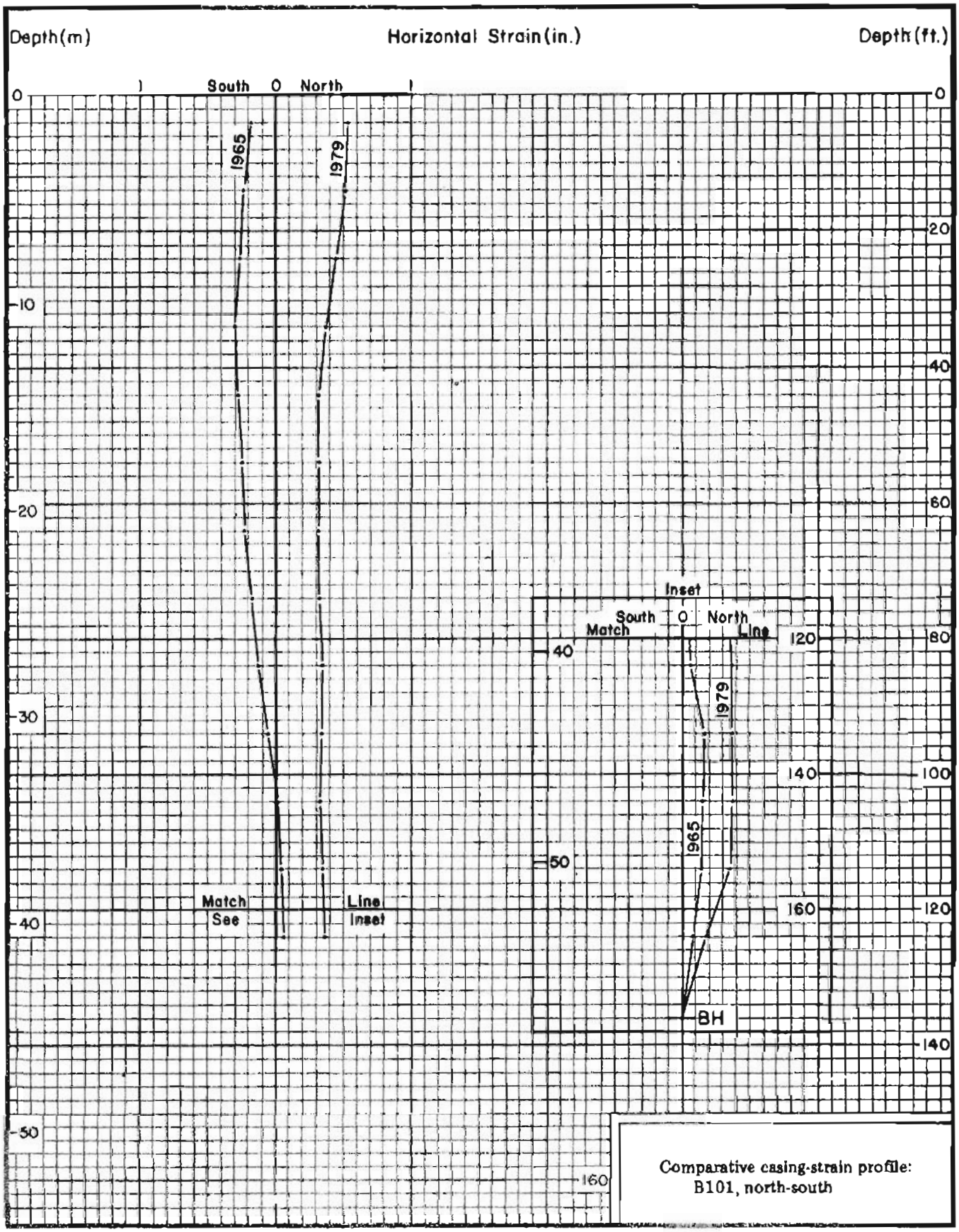
Comparative casing-strain profile:
B3, east-west



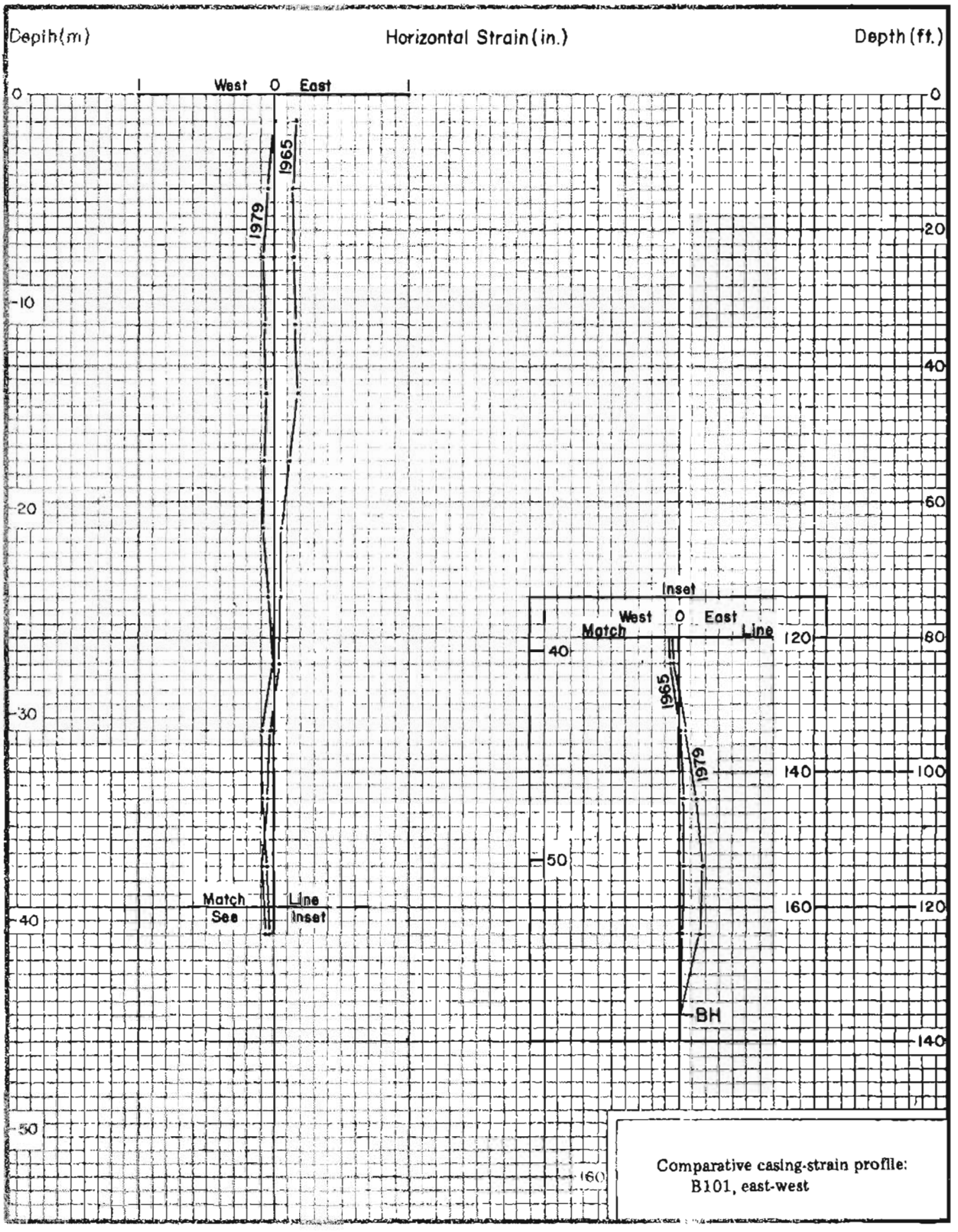
Comparative casing-strain profile:
B4, north-south



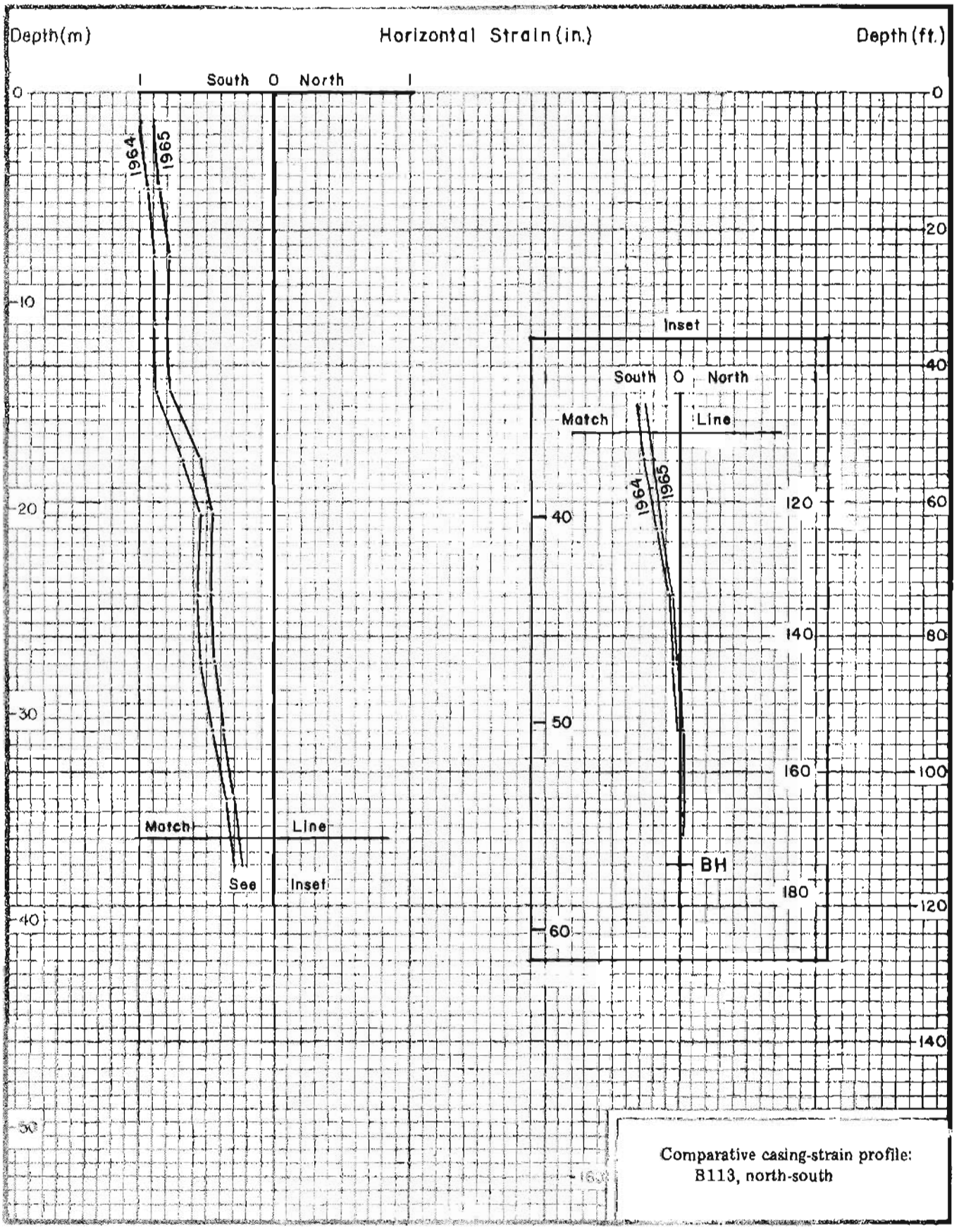
Comparative casing-strain profile:
B4, east-west



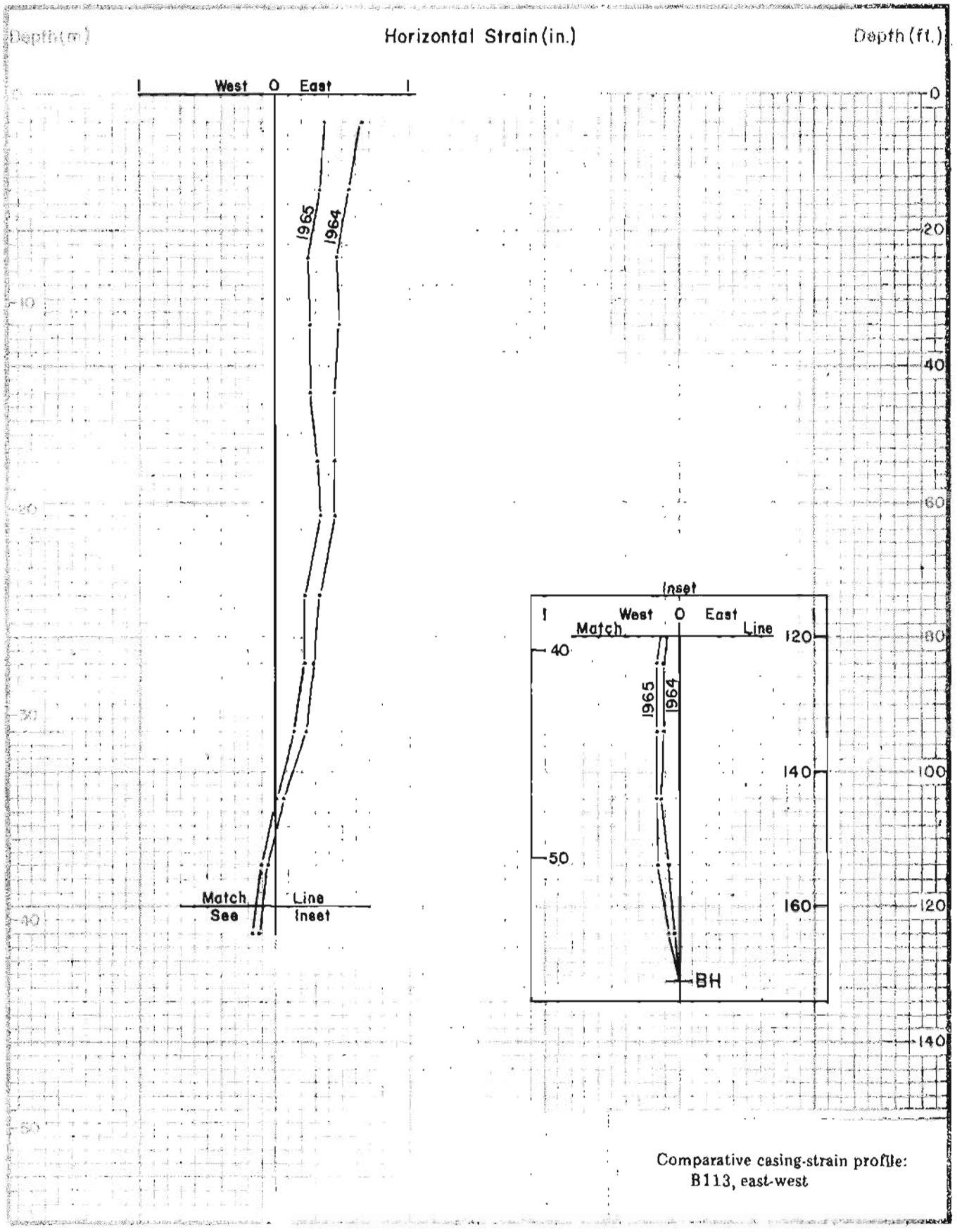
Comparative casing-strain profile:
B101, north-south



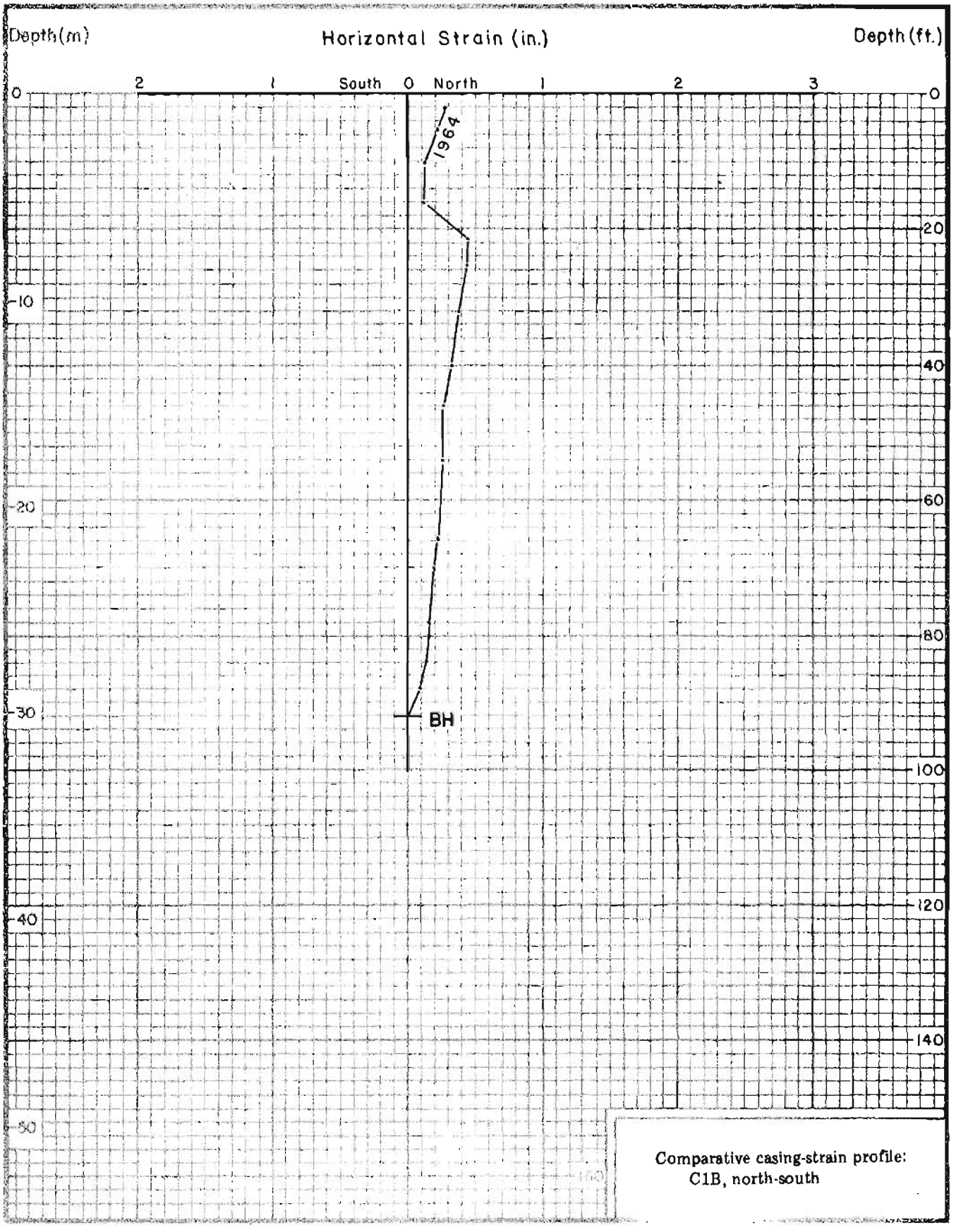
Comparative casing-strain profile:
B101, east-west



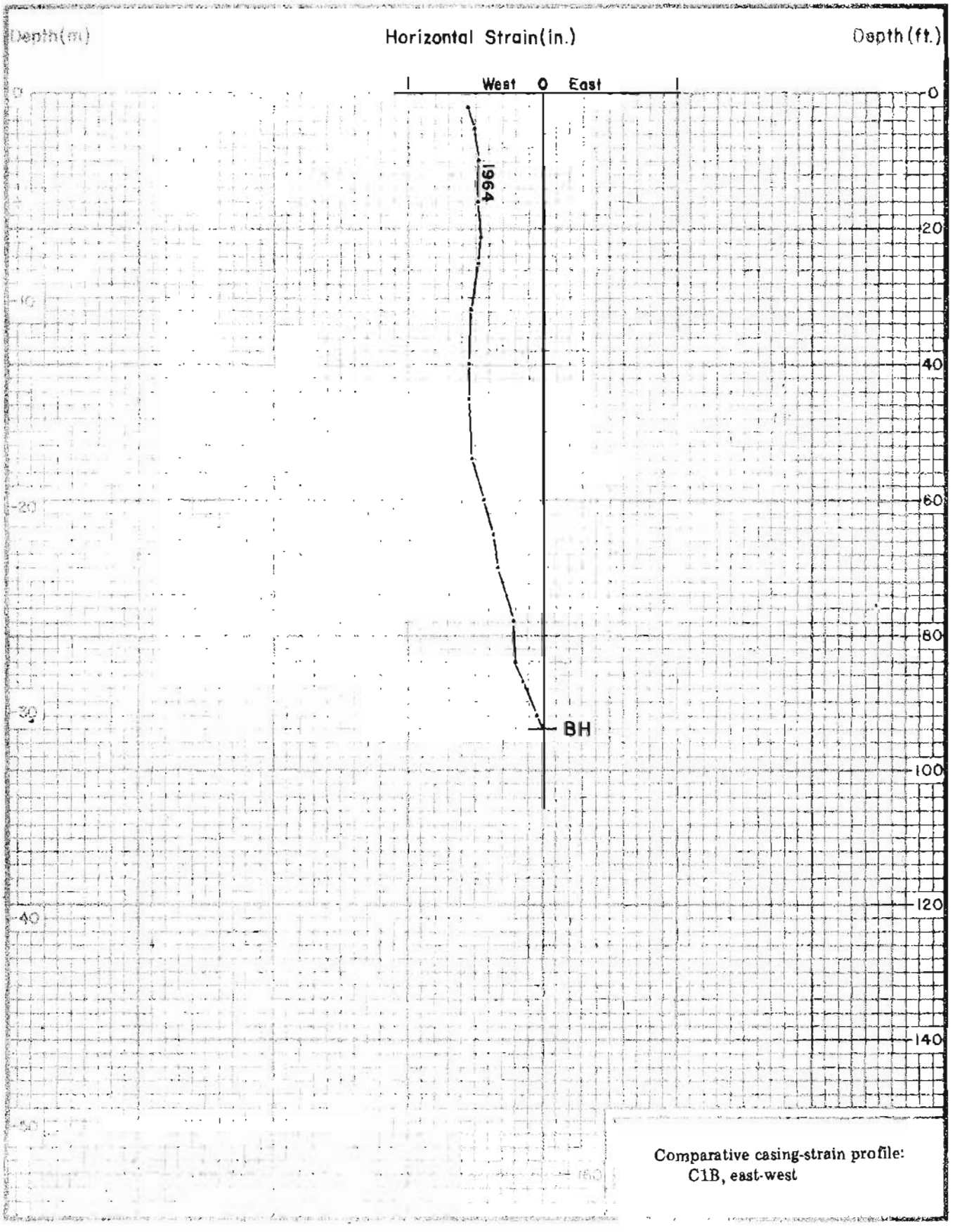
Comparative casing-strain profile:
B113, north-south



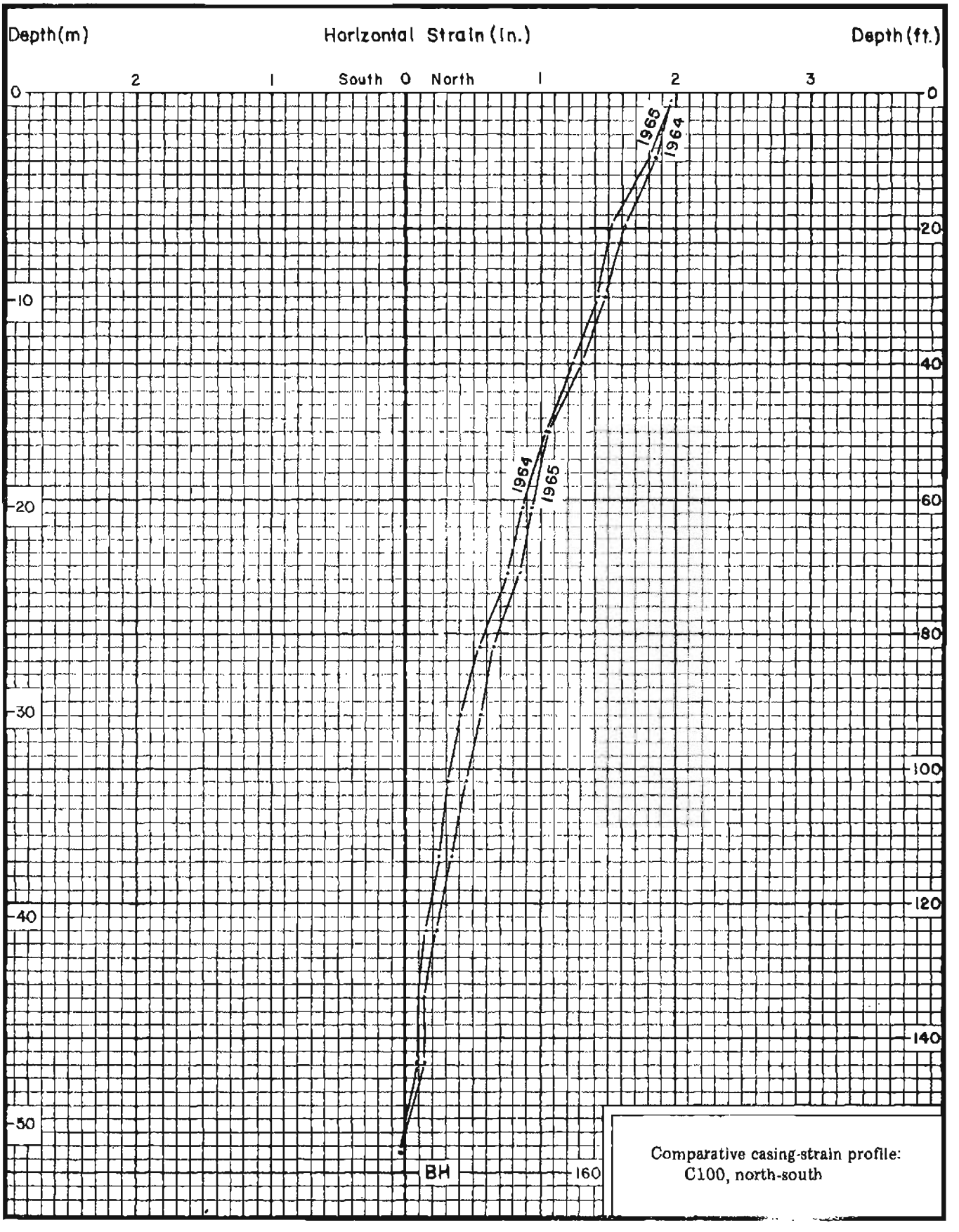
Comparative casing-strain profile:
B113, east-west



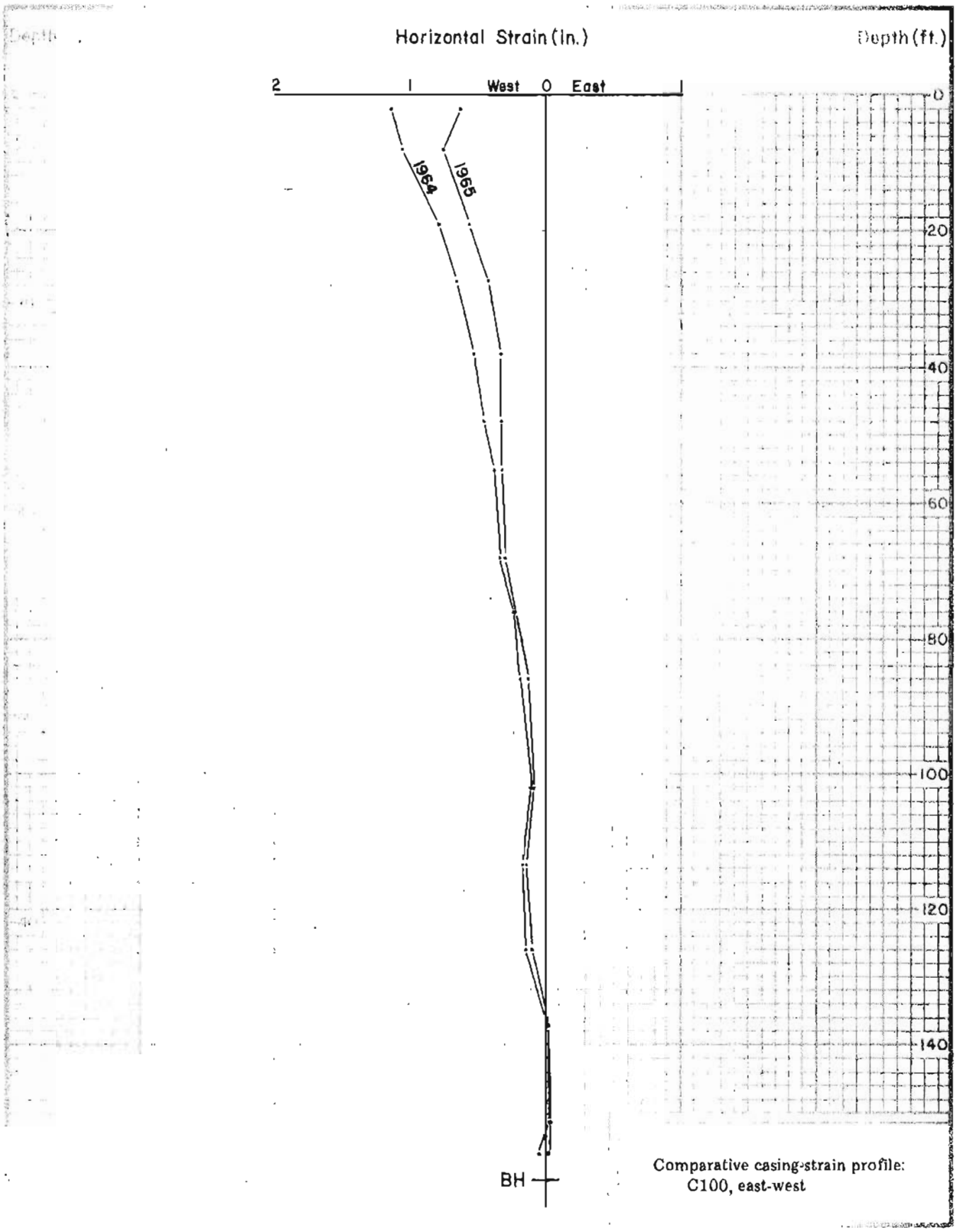
Comparative casing-strain profile:
C1B, north-south



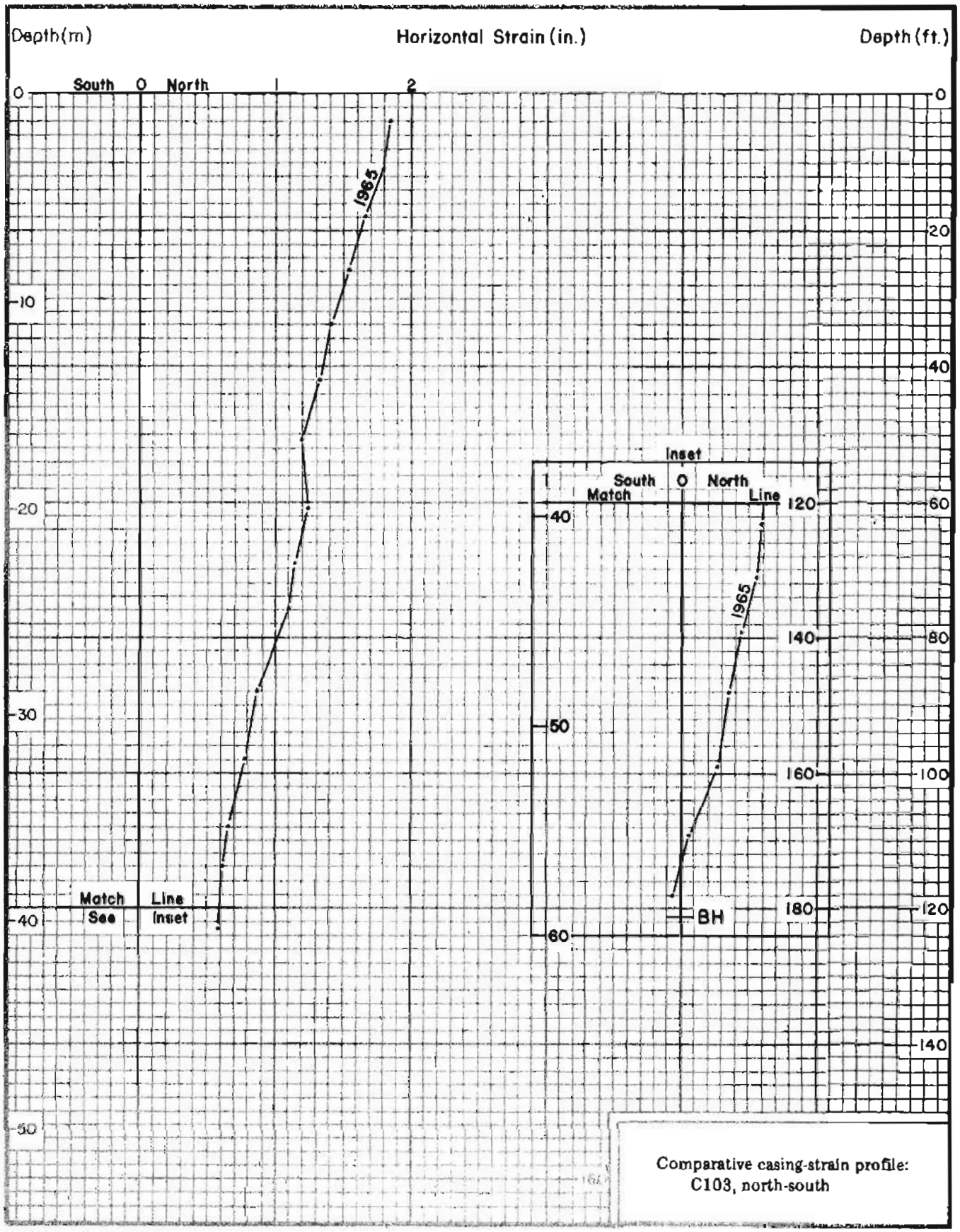
Comparative casing-strain profile:
C1B, east-west



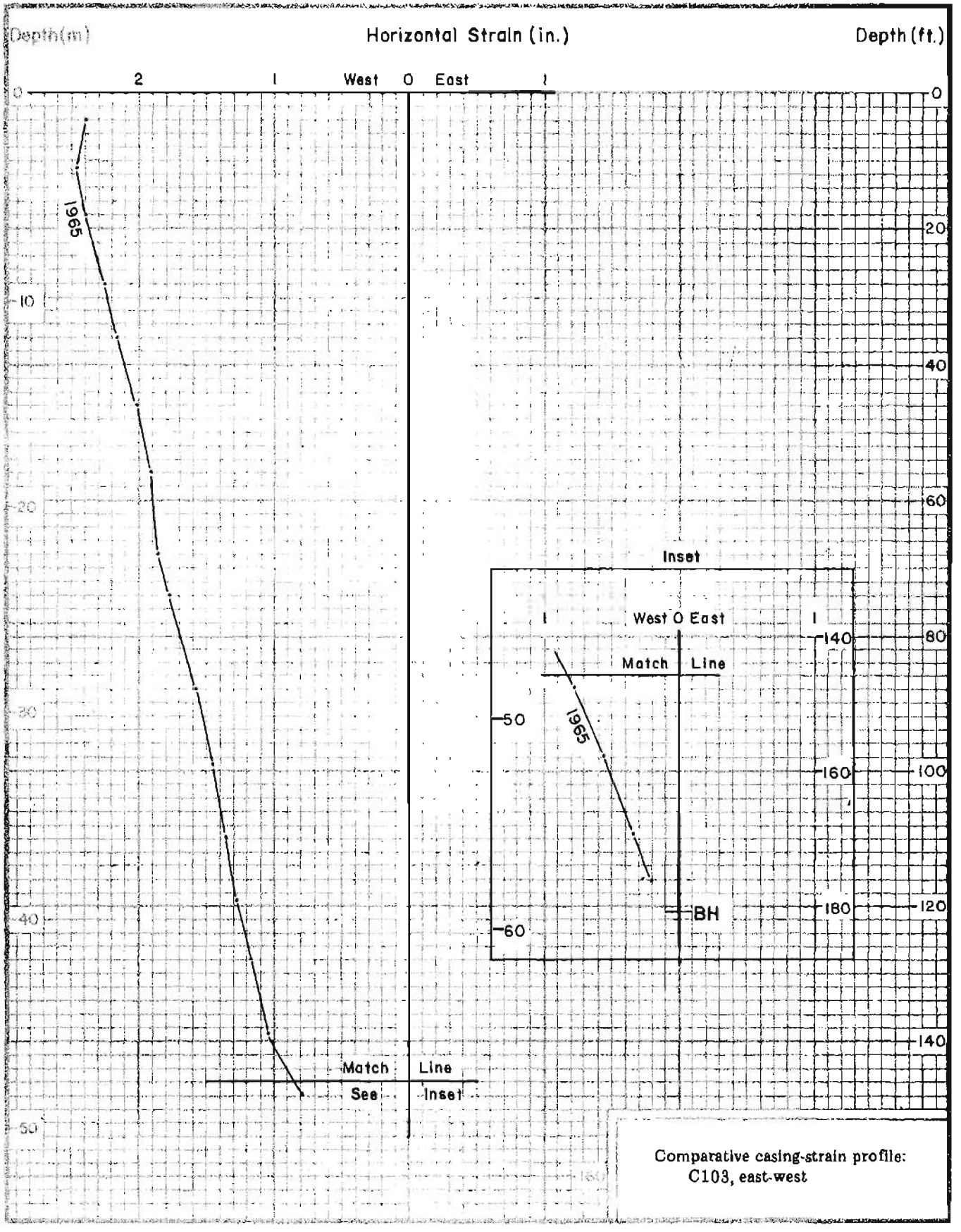
Comparative casing-strain profile:
C100, north-south



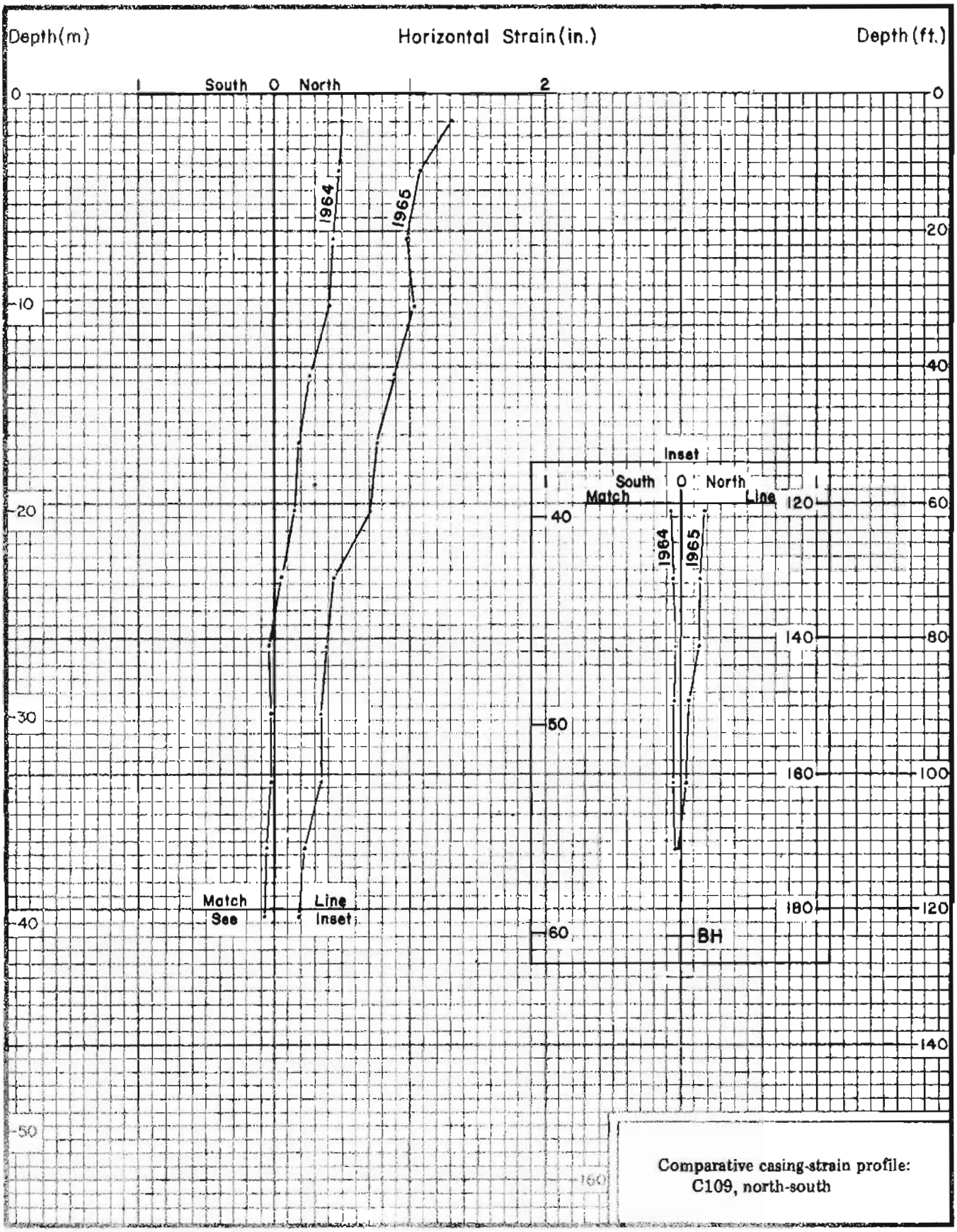
Comparative casing-strain profile:
C100, east-west



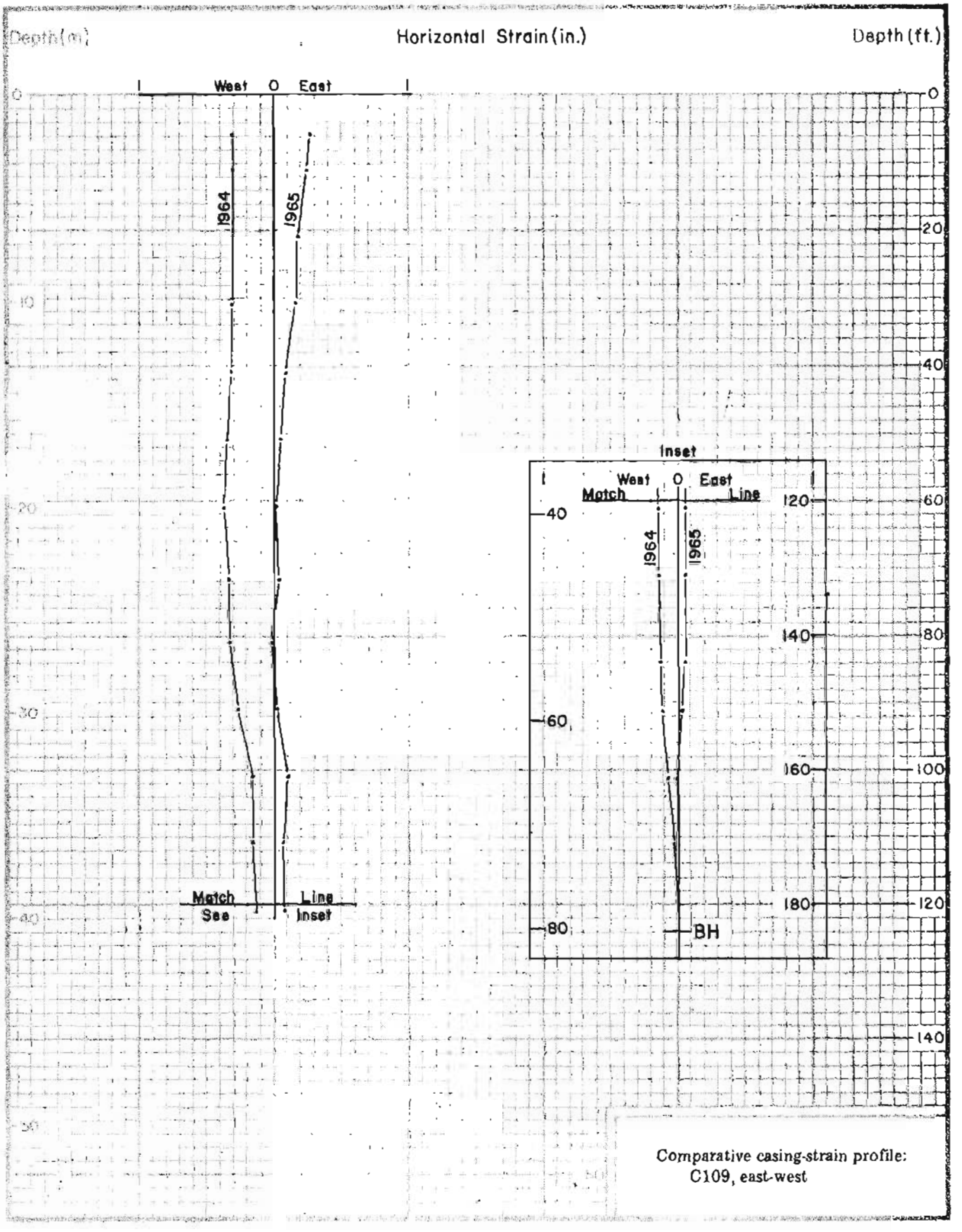
Comparative casing-strain profile: C103, north-south



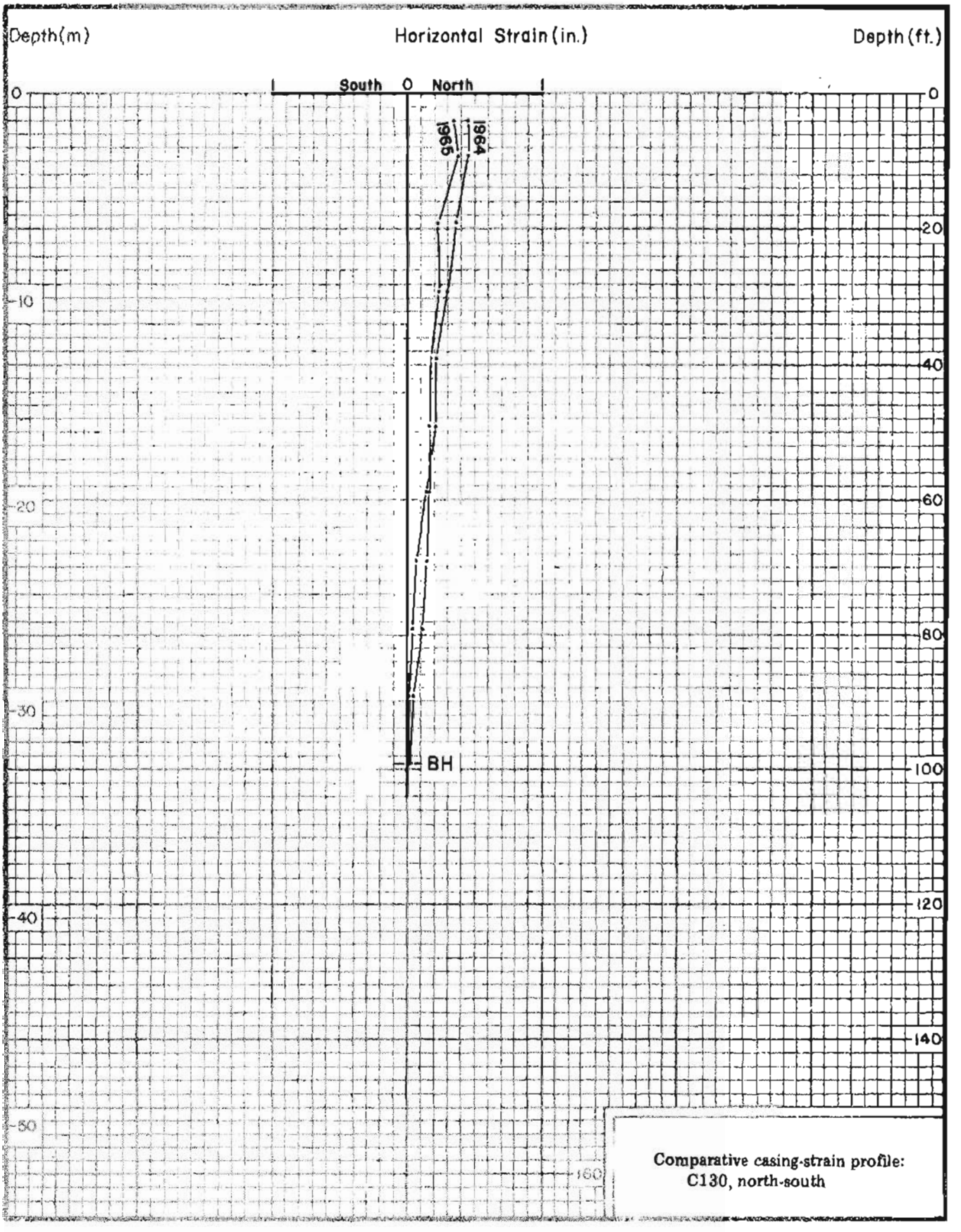
Comparative casing-strain profile:
C103, east-west



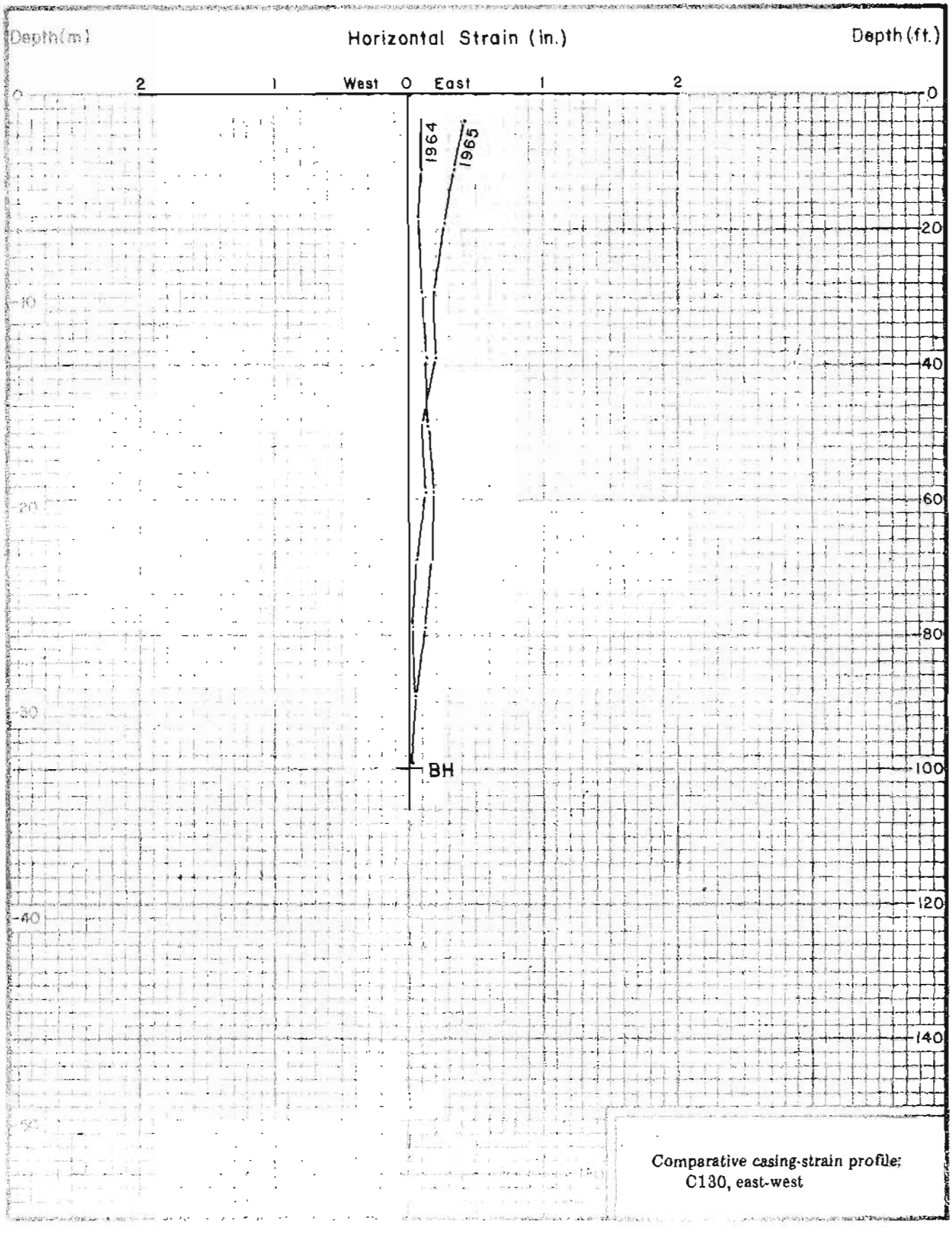
Comparative casing-strain profile: C109, north-south



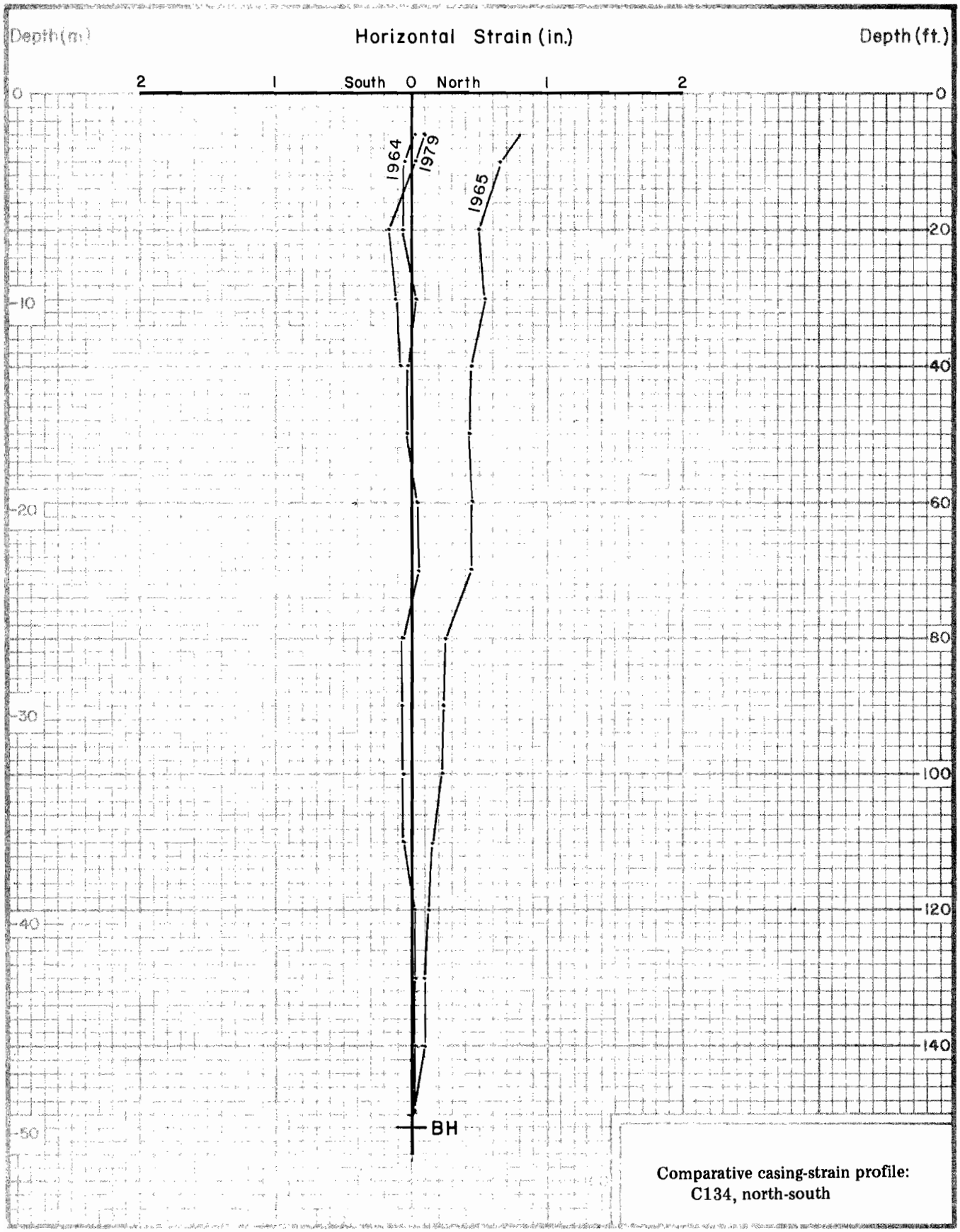
Comparative casing-strain profile:
C109, east-west



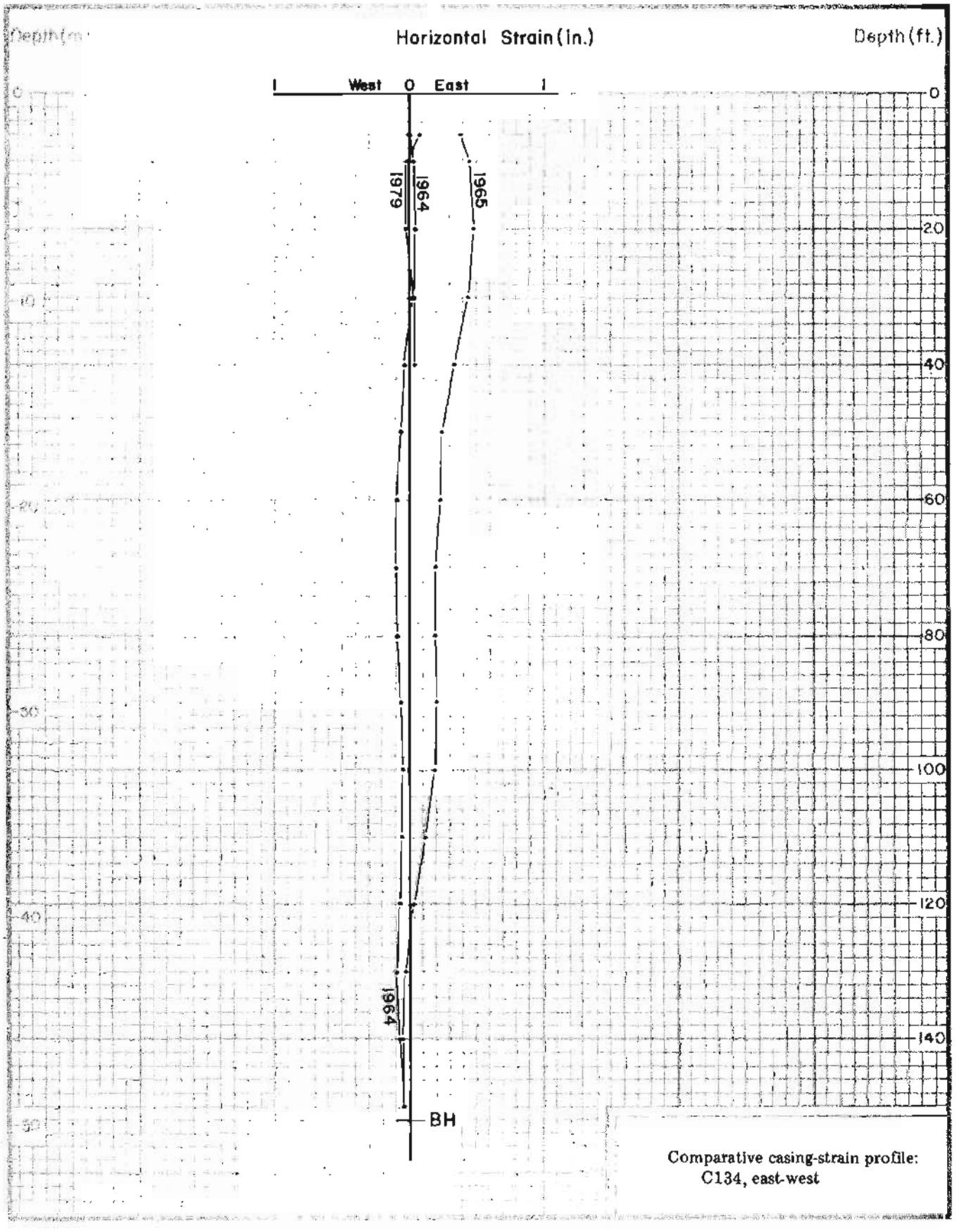
Comparative casing-strain profile: C130, north-south



Comparative casing-strain profile: C130, east-west



Comparative casing-strain profile: C134, north-south



Comparative casing-strain profile:
C134, east-west

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