Recovery of Gas Hydrates: Many Ideas, Any Solutions?

Gas hydrates have the basic problem that their endothermic decomposition requires heat that the poor conduction of rocks and soils cannot provide at the appropriate rate.

So the first idea is to try to bring heat from above. The imagination of the inventors produced some rudimentary paper proposals which we report as they may be the basis of more evolved ones.

As said before, in my opinion the best trick is to inject CO_2 in the hydrate layers, and use its heat of hydration to pull CH_4 out. This line is followed in Japan already.

The description of the various possibilities when injecting steam to heat the hydrates to decomposition are schematically given in Figs.7–14. To my knowledge there is no systematic experimentation yet on these methods although in many ways they resemble the ones used to extract thick oils.

A CO_2 injection system would work exactly with the same mechanism. However, fixation should be precise as CO_2 does not separate as easily as steam in case it is carried back by ascending methane.

In actual operation very little shows up. Filtering the outcome of a recent "Gas Hydrates" workshop at the University of Leeds (April 1998), one finds a sizable amount of explorations, even in out of hand oceanic places, but no actual extraction experiments, except the ones *announced* by Japanese sources (Tokyo and Osaka Univerities, JAPEX, and JNOC) for drilling in the Nankai trough.

Excellent papers on the physical chemistry of hydrates containing CH_4, CO_2, C_2H_6 and other components have recently been published by R.K. Bakker. These studies can be of fundamental importance in establishing the right strategy to extract CH_4 from hydrates.

SCHEMATIC OF STEAM INJECTION INTO A HYDRATE RESERVOIR

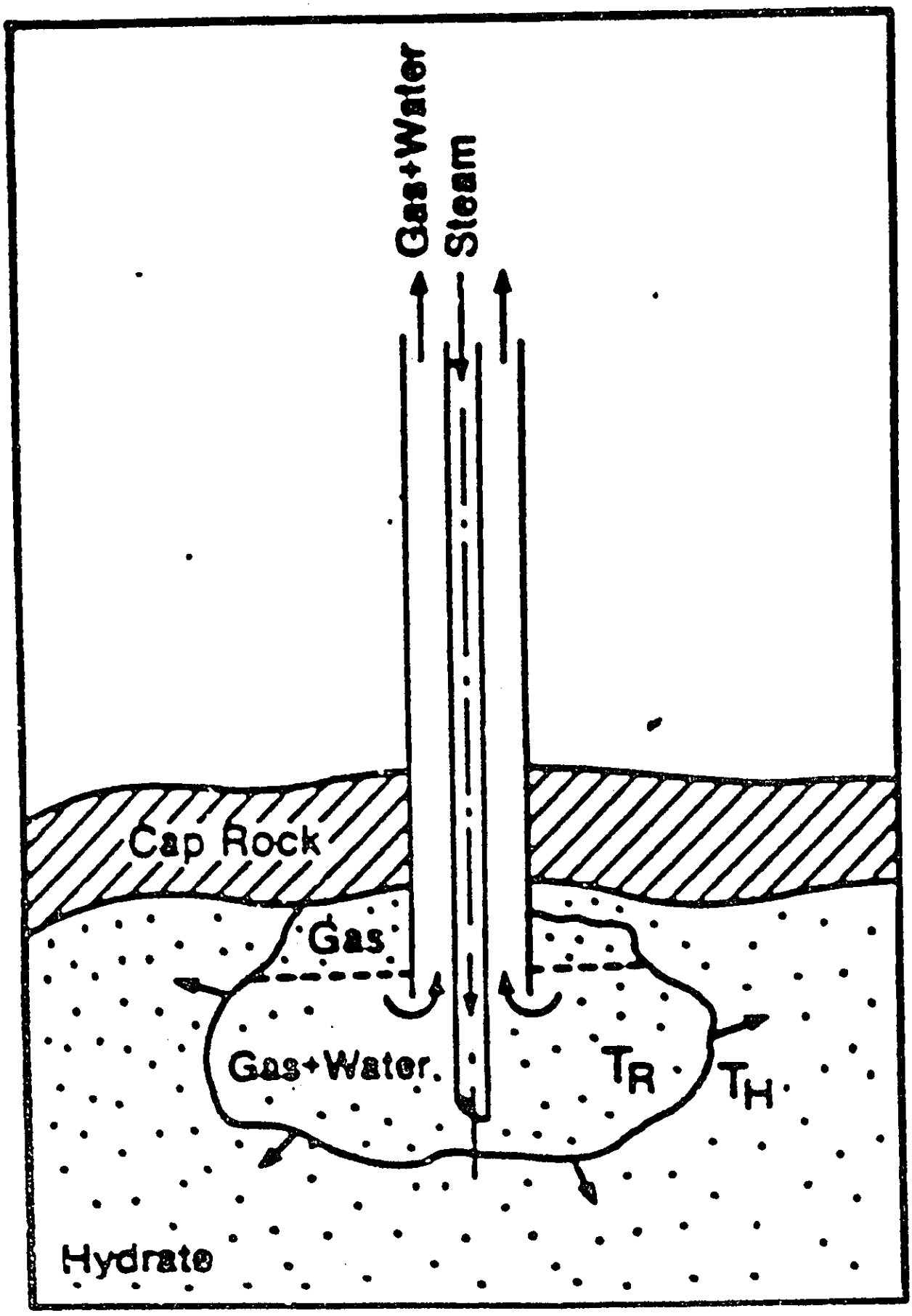


Fig.7.

ILLUSTRATION OF RADIAL STIMULATION
(TOP VIEW)

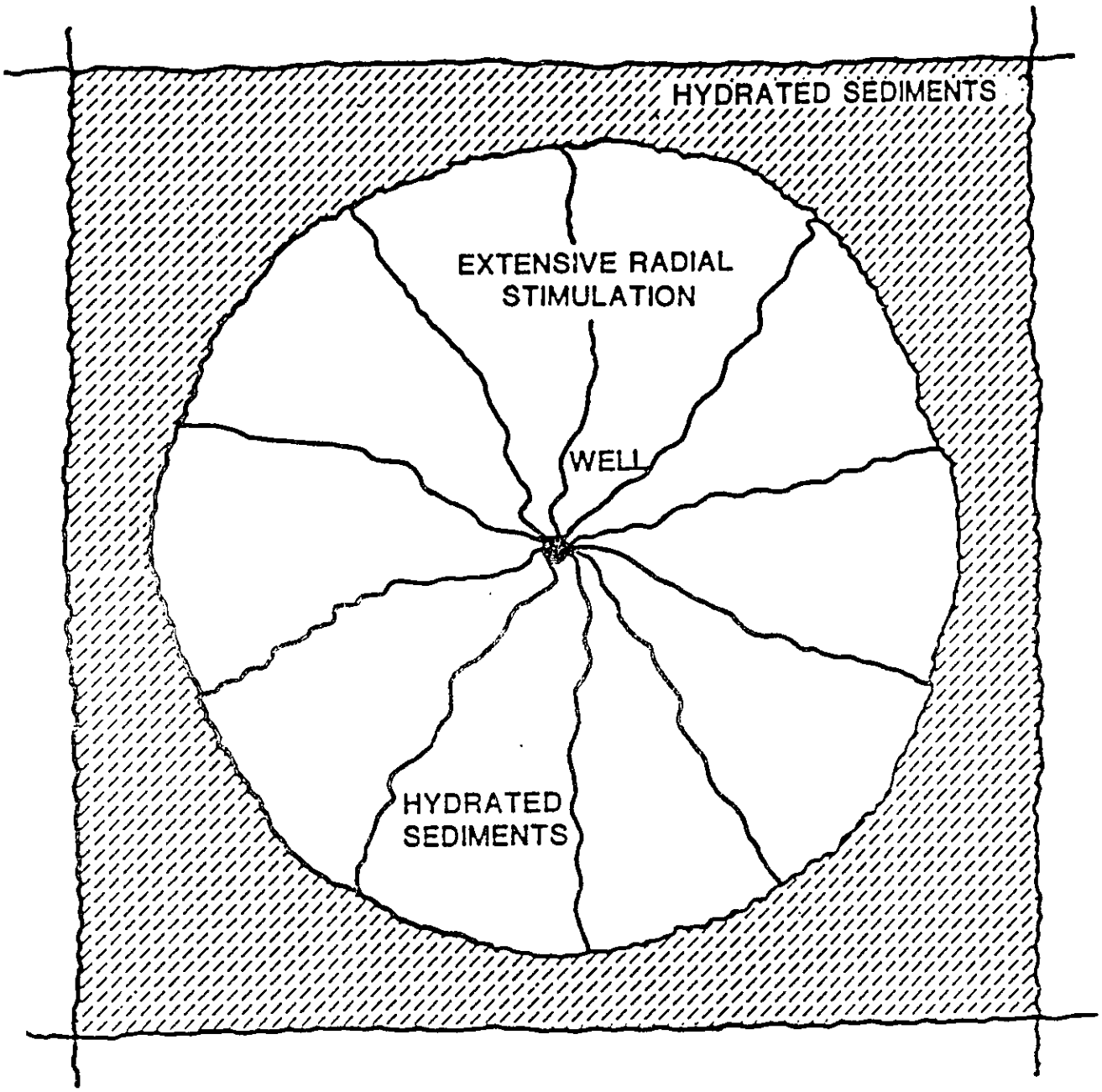


Fig.8.

CONTINUOUS STEAM MODEL WITH HORIZONTAL FRACTURE
(SIDE VIEW)

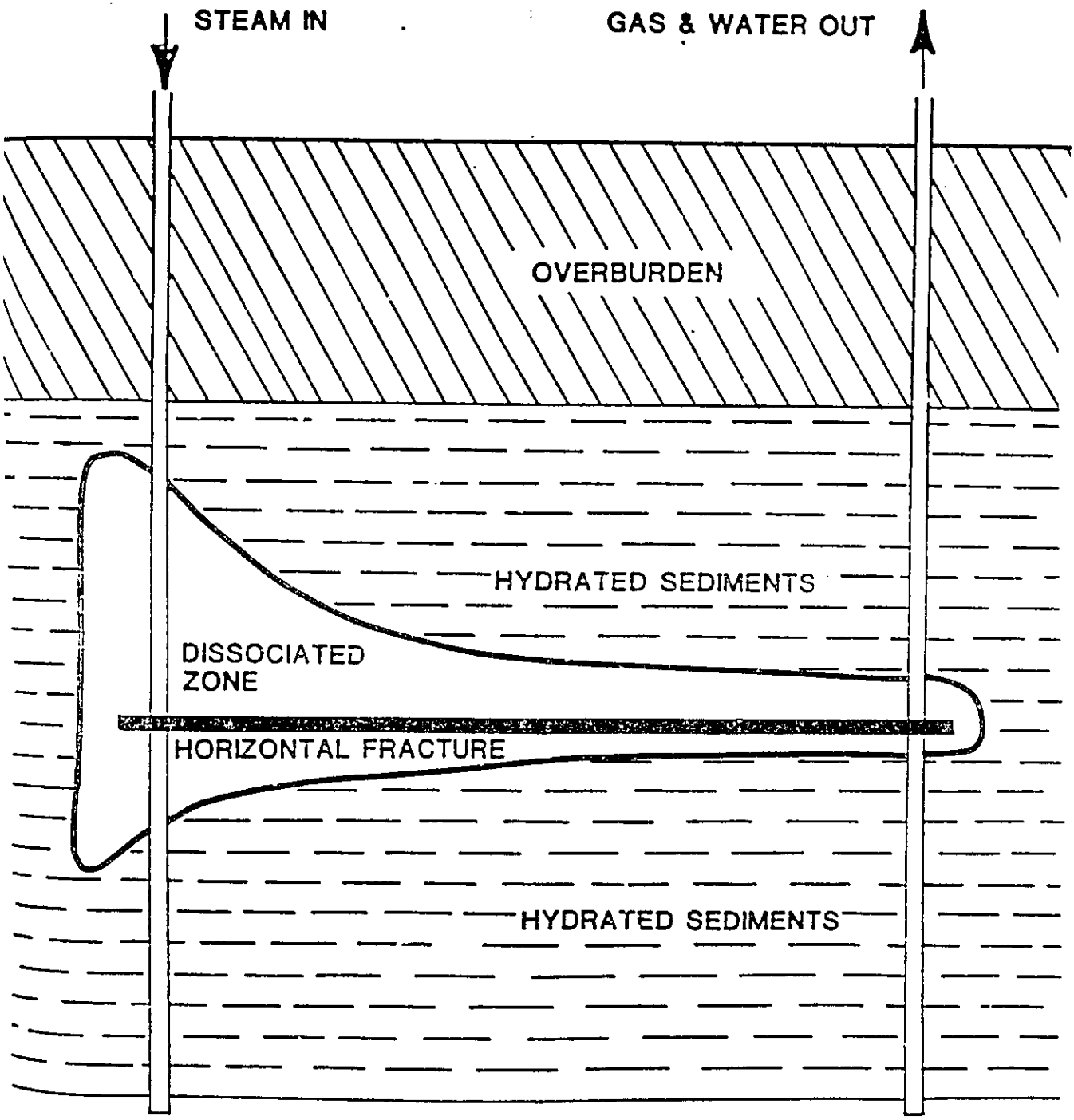


Fig.9.

DETAILED DESCRIPTION OF
CONTINUOUS INJECTION MODEL WITH HORIZONTAL FRACTURE
(SIDE VIEW)

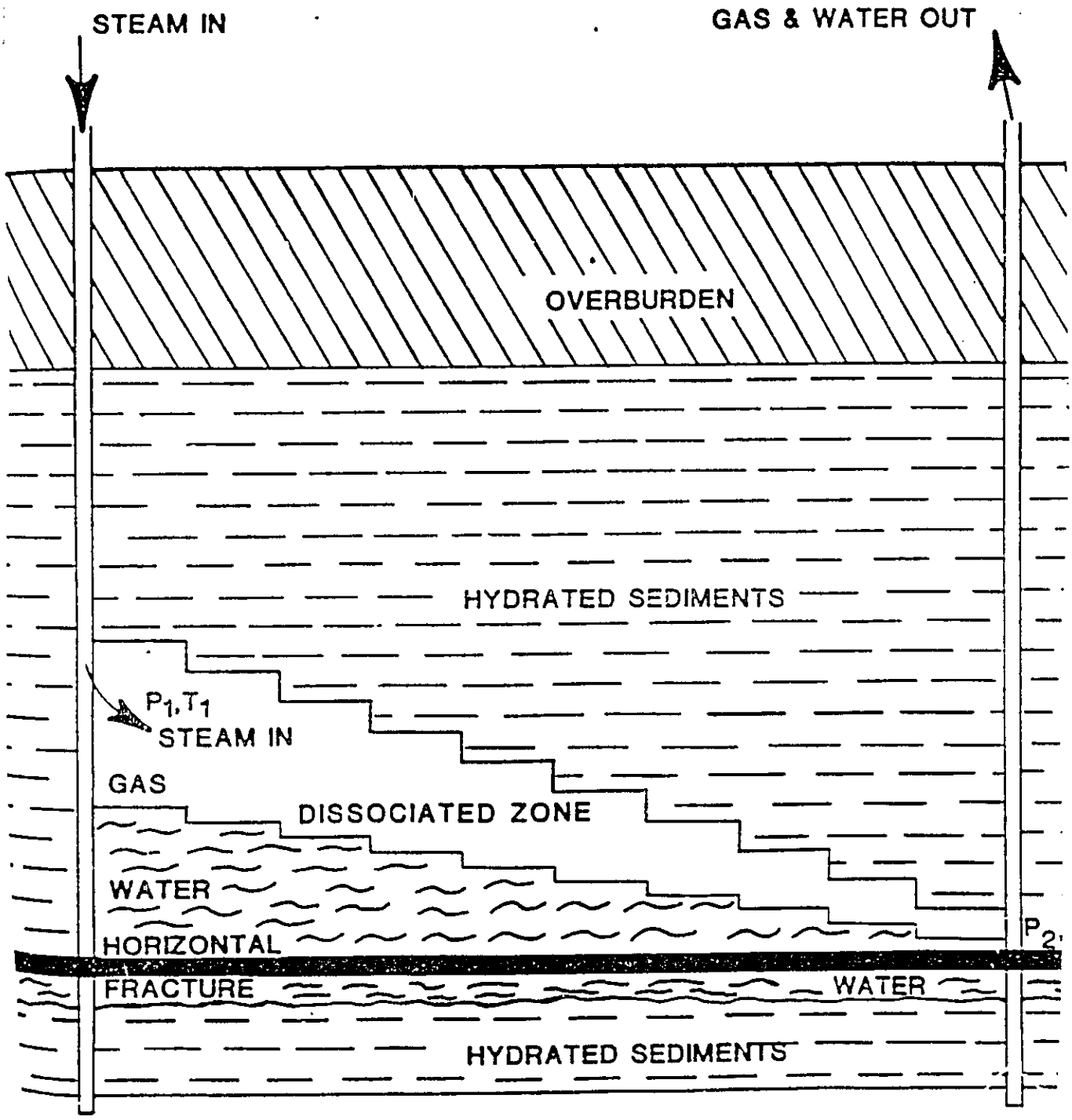


Fig.10.

HEAT CONDUCTION PROBLEM IN VERTICAL DIRECTION
FOR HORIZONTAL FRACTURE CASE - CYCLIC MODEL
(SIDE VIEW)

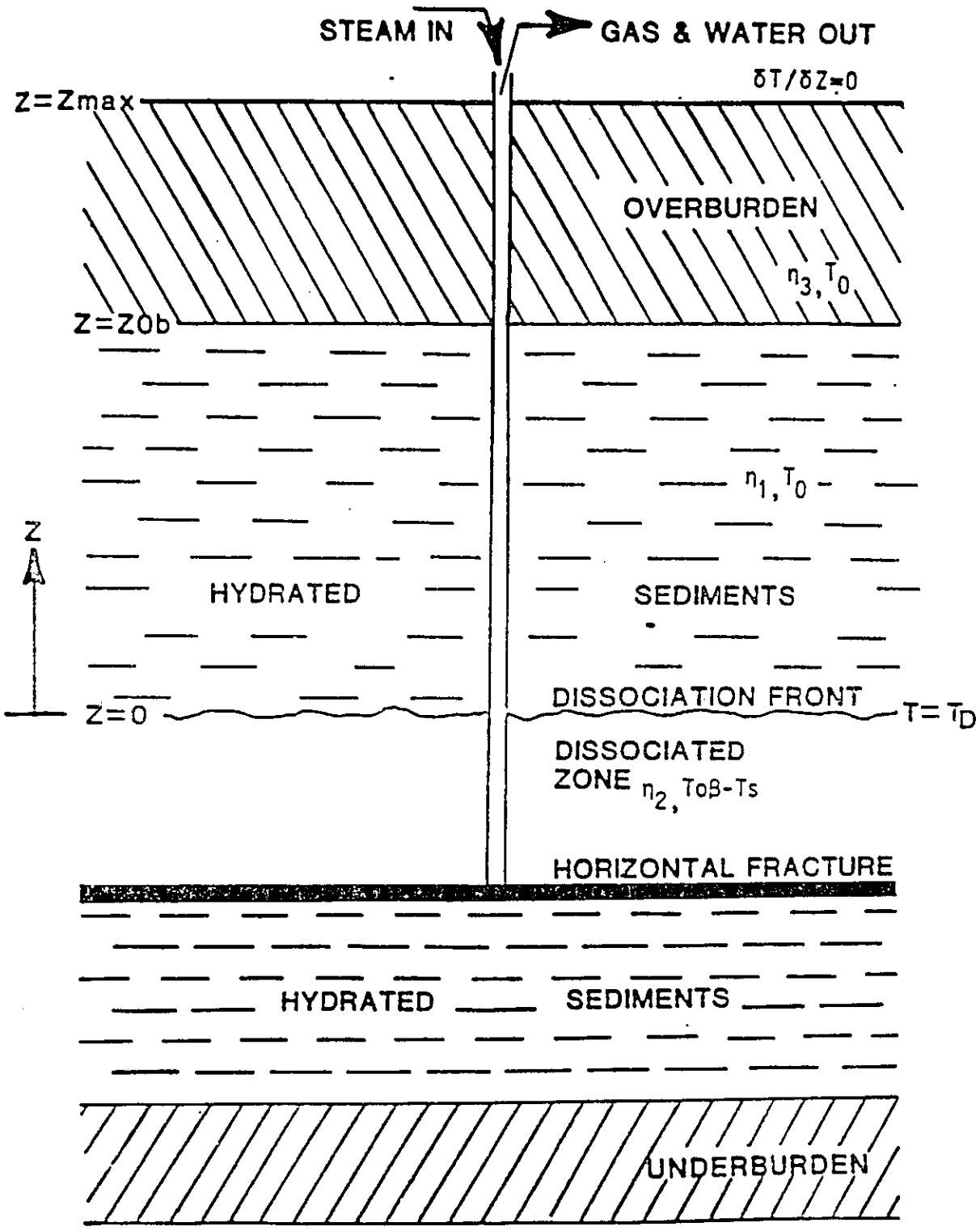


Fig.11.

CONTINUOUS STEAM MODEL WITH VERTICAL FRACTURE

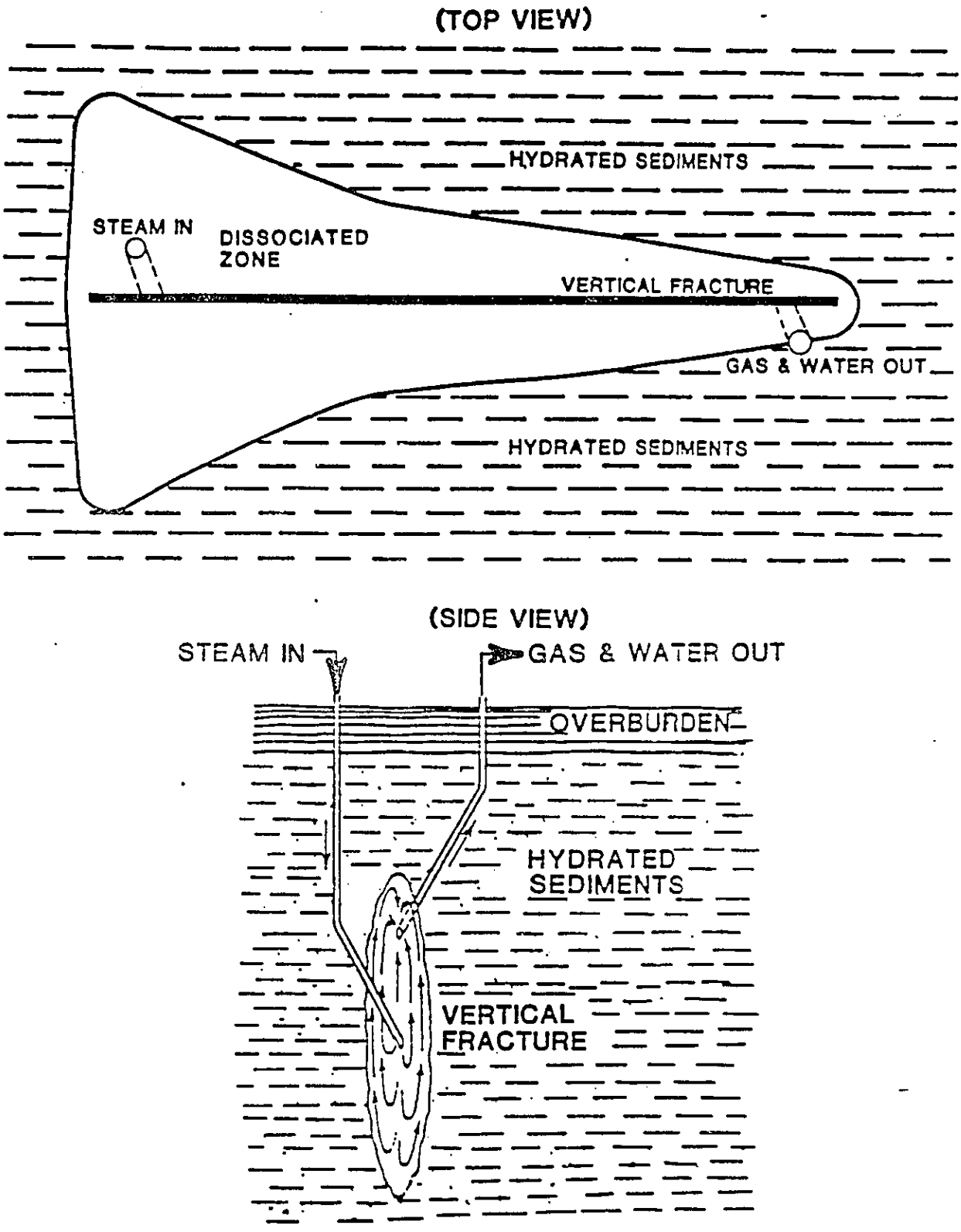


Fig.12.

HEAT CONDUCTION PROBLEM IN HORIZONTAL DIRECTION
FOR VERTICAL FRACTURE CASE - CYCLIC MODEL
(TOP VIEW)

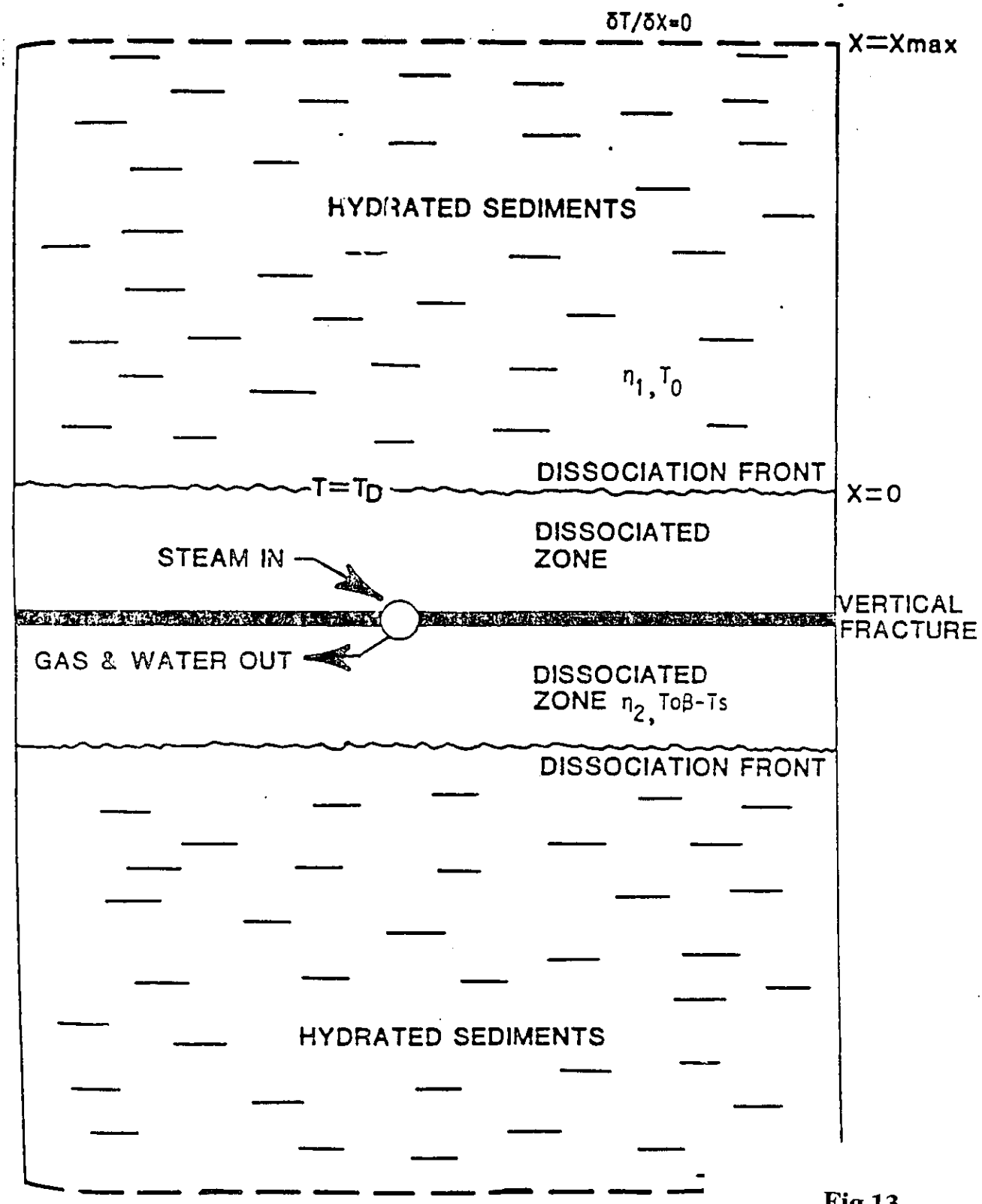


Fig.13.

DECOMPRESSION HYDRATE CAP MODEL WITH HORIZONTAL FRACTURE
(SIDE VIEW)

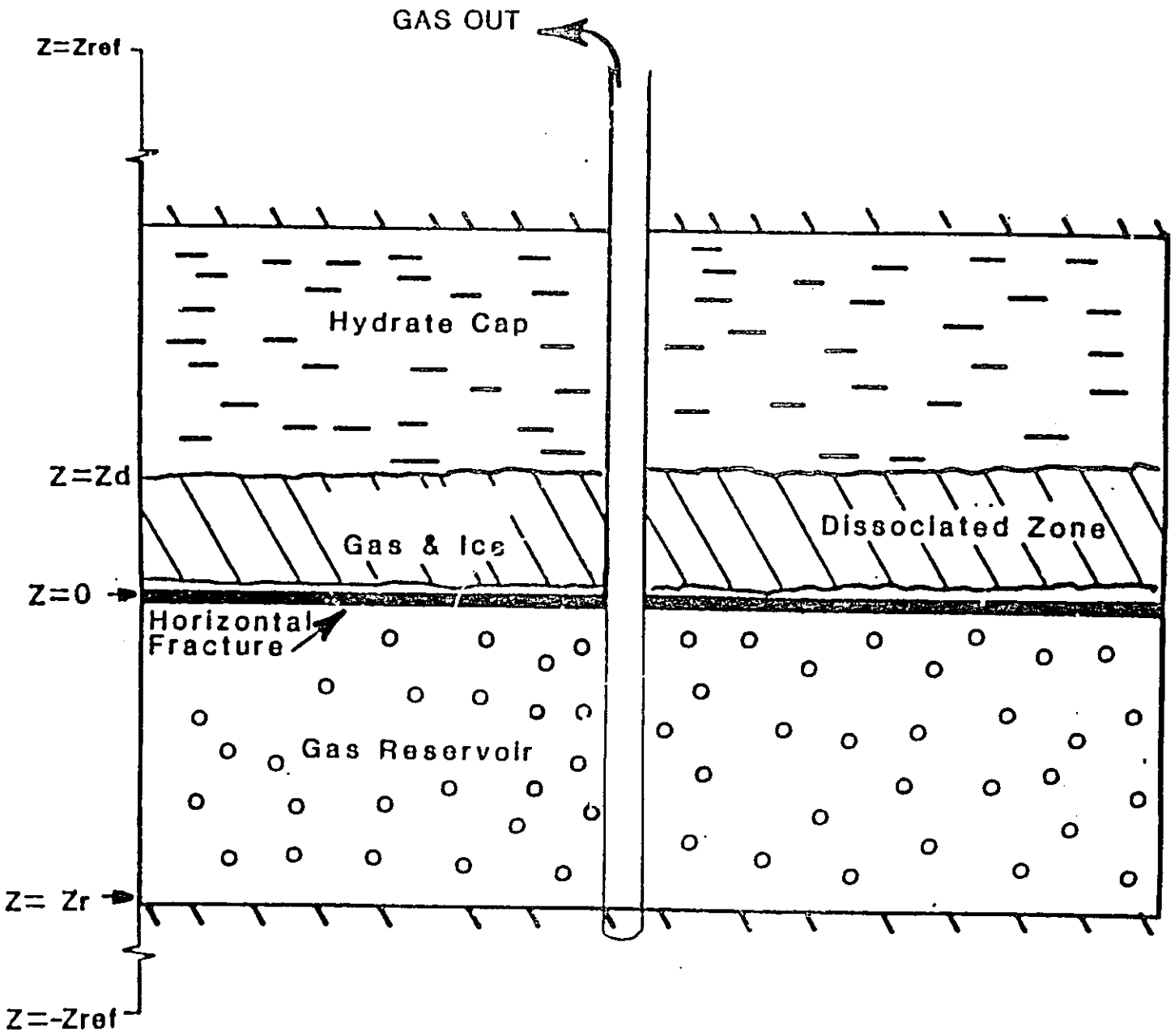


Fig.14.

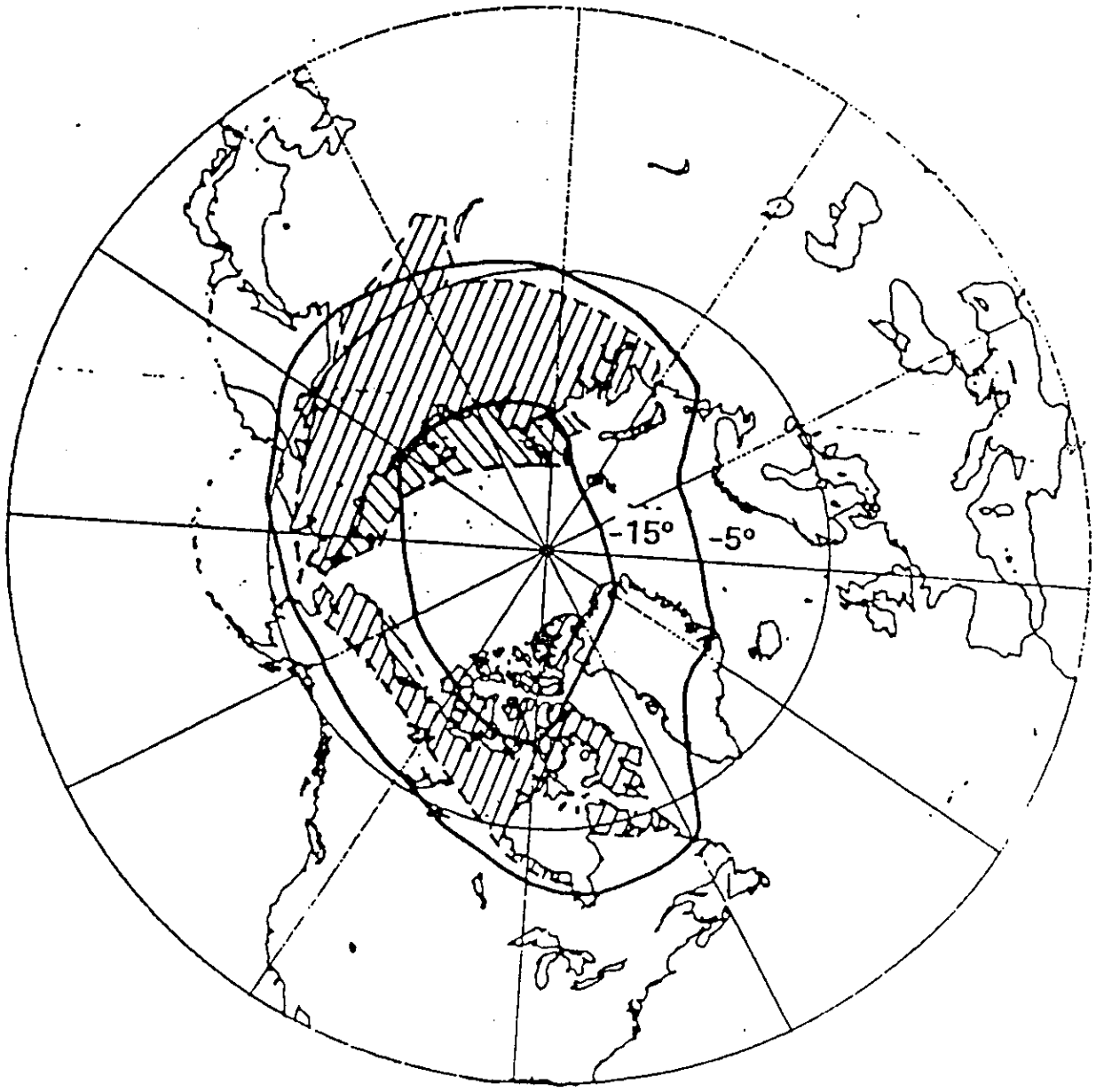
What about Hydrates Under Permafrost

Having a mean surface temperature around –10°C creates conditions for hydrate formation under the land. Normally, the geothermal gradient produces too high temperatures versus depth, i.e., pressure, to find zones of hydrate stability.

Because working on terra firma is much easier than working over the ocean, there is a special interest for detecting and hopefully exploiting gas hydrates under permafrost, i.e., geographically in boreal regions.

As Fig.15 shows, most permafrost land (and ocean) are located in Russia. The hydrate reserves could then be found at very convenient depths, between 300 and 1000 meters (Fig.16).

As said before, because these hydrate layers could accommodate CO_2 in place of CH_4, it would be very ecological *if the Russians could reform their CH_4 to $4H_2$ and CO_2 and pipe H_2 to the final consumers. It could be their best contribution to the Kyoto agreements.*



The approximate location of the −5° and −15°C isotherms of annual mean surface air temperature and the areas of continuous Northern Hemisphere permafrost and identified subsea permafrost. (Permafrost data courtesy of Jerry Brown of the U.S. Army's Cold Regions Research and Engineering Laboratory.)

Fig.15.

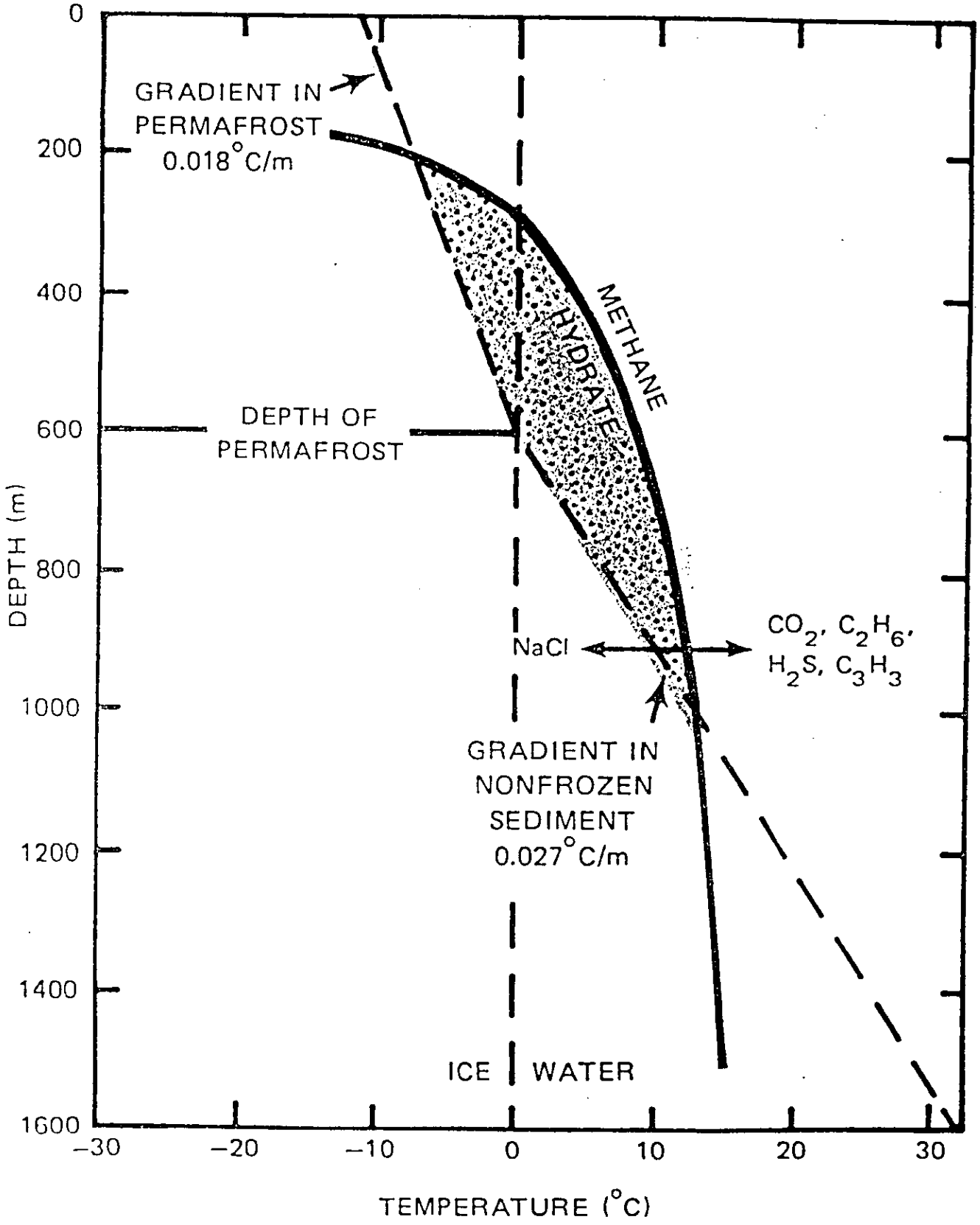

0
200
400
600
800
1000
1200
1400
1600
DEPTH (m)
GRADIENT IN
PERMAFROST
0.018°C/m
METHANE
HYDRATE
DEPTH OF
PERMAFROST
NaCl
CO_2, C_2H_6,
H_2S, C_3H_3
GRADIENT IN
NONFROZEN
SEDIMENT
0.027°C/m
ICE
WATER
−30
−20
−10
0
10
20
30
TEMPERATURE (°C)

Fig.16.

Who Is Doing Research on Gas Hydrates

We scanned the listed literature, and some not listed, to try to find out whether there are centers of excellence, so to say, for research on hydrates.

We found really none. The papers come from disparate places, basically universities, showing that the driving force is just academic curiosity.

In the case of Russia, a number of papers come from Moscow inevitably, but also from Irkutsk (that has a computer model to establish where hydrates can be found) and Novosibirsk.

The coagulation points can be expected when real interest and proportionate money will start moving. The Russian–Indian deal may foster research in Russia. Gasprom is the richest company in Russia. And Japan is also condensing a line of action with various institutions collaborating.

Some driving forces in the study and practical handling of hydrate may come from the possibility, recently suggested, *to transport methane in form of hydrate*. A slurry of hydrate would be mixed with crude oils and shipped in current oil tankers, at atmospheric pressure. To ensure stability one should cool to –10°C or so, but decomposition of hydrate grains generate an ice skin on the grain and finally practice will suggest the best compromise. A certain decomposition level can be acceptable if the evolving gas can be used to propel the ship.

At present an amount of gas equivalent to the whole consumption in Europe is flared around the world because of the expense of transporting methane over long distances as LNG. A cheap way could mobilize important resources and incidentally *reduce CO_2 emissions in a very important measure* (equivalent to zeroing Europe's emissions, more or less). A fact which Kyoto legislators did not seem to have weighted sufficiently.

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Annex

Japanese Papers on CO_2 and CH_4 Hydrates

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      $8.95  Estimated cost this search
      $8.97  Estimated total session cost   0.056 Hrs.

File  94:JICST-EPlus  1985-1997/Mar W2
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        or
          136677  GAS
            4829  GASES
            1688  CLATHRATE?
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03332260   JICST ACCESSION NUMBER: 96A0591411  FILE SEGMENT: JICST-E
Molecular Dynamics Simulation of Clathrate-Hydrate Formation.
HIRAI SHUICHIRO (1); OKAZAKI KEN (1); KURAOKA SHINSUKE (2); KAWAMURA
    KATSUYUKI (3)
(1) Tokyo Inst. of Technol.; (2) Tokyo Inst. of Technology, Graduate School
; (3) Tokyo Inst. of Technol. Fac. of Sci.
Nippon Dennetsu Shinpojiumu Koen Ronbunshu, 1996, VOL.33rd,NO.Vol 1,
    PAGE.339-340, FIG.3, REF.1
JOURNAL NUMBER: F0872CAE
UNIVERSAL DECIMAL CLASSIFICATION: 548.73:544.142.3/.4
LANGUAGE: Japanese          COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Conference Proceeding
ARTICLE TYPE: Short Communication
MEDIA TYPE: Printed Publication
ABSTRACT: The phenomena of clathrate-hydrate formation has been conducted
    by molecular dynamics simulation. Positions of Ar molecules(guest
    molecules) were fixed and formation of cage structure by H2O molecules
    around the Ar molecules were precisely simulated by the present
    calculation. The interpretation of the formation mechanism was
    discussed in detail. (author abst.)
DESCRIPTORS: clathrate compound; hydrate; water molecule; molecular
    dynamics; argon; water; intermolecular interaction; hydrogen bond;
    computer simulation; molecular orientation
BROADER DESCRIPTORS: molecular compound; addition compound;
    compound(chemical); solvate; triatomic molecule; polyatomic molecule;
    molecule; dynamics; rare gas; element; third row element; interaction;
    binding and coupling; computer application; utilization; simulation;
    orientation(direction)
CLASSIFICATION CODE(S): BK09050T


 3/9/3
DIALOG(R)File  94:JICST-EPlus
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03166561   JICST ACCESSION NUMBER: 96A0155971  FILE SEGMENT: JICST-E
Formation and dissolution of CO2 clathrate hydrate under deep-ocean
    disposal conditions.
WARZINSKI R P (1); CUGINI A V (1); HOLDER G D (2)
(1) Pittsburgh Energy Technol. Center, U.S. Dep., PA, USA; (2) Univ.
    Pittsburgh, PA, USA
Ionics, 1995, VOL.21,NO.12 bessatsu, PAGE.5-7, REF.2
JOURNAL NUMBER: F0043BAT    ISSN NO: 0388-659X
UNIVERSAL DECIMAL CLASSIFICATION: 628.511
LANGUAGE: English          COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Short Communication
MEDIA TYPE: Printed Publication
DESCRIPTORS: air pollution; global warming; carbon dioxide; exhaust gas
    treatment; undersea storage; hydrate; clathrate compound; droplet;
    covering; fixation; sea disposal
IDENTIFIERS: deep sea disposal
BROADER DESCRIPTORS: environmental pollution; pollution; warming(climatic);
    climatic variation; fluctuation and variation; carbon oxide; oxide;
    chalcogenide; oxygen group element compound; oxygen compound; carbon
    compound; carbon group element compound; waste treatment; treatment;
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storage; solvate; addition compound; compound(chemical); molecular compound; surface treatment; underwater disposal; waste disposal
CLASSIFICATION CODE(S): SC04020W

3/9/4
DIALOG(R)File 94:JICST-EPlus

02966629 JICST ACCESSION NUMBER: 95A0694225 FILE SEGMENT: JICST-E
High-pressure phase behavior of the mixed system including CO2 clathrate hydrate.
OGAKI KAZUNARI (1); HAMANAKA TAKAHIRO (1)
(1) Osaka Univ., Fac. of Eng. Sci.
Kagaku Kogaku, 1995, VOL.59,NO.8, PAGE.583-584, FIG.3, REF.3
JOURNAL NUMBER: F0099AAT ISSN NO: 0375-9253 CODEN: KKGKA
UNIVERSAL DECIMAL CLASSIFICATION: 66.021.4
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Short Communication
MEDIA TYPE: Printed Publication
ABSTRACT: A visible type high-pressure cell of 100MPa resistant provided with vibrational agitation was prepared. The coexistance relations of CO2 hydrate, liquid CO2 and H2O was measured up to a maximum pressure of 82MPa. With deep-sea bed storage of CO2 in mind, density reversion phenomena of CO2 hydrate, liquid CO2 and H2O phases depending on changes in temperature and pressure was observed. From these results, the possibility of a long-term stability storage of liquid CO2 in the Japan Deep was suggested.
DESCRIPTORS: carbon dioxide; clathrate compound; hydrate; high pressure; multiphase; phase diagram; mixture; water; liquefied gas; density; natural gas
BROADER DESCRIPTORS: carbon oxide; oxide; chalcogenide; oxygen group element compound; oxygen compound; carbon compound; carbon group element compound; molecular compound; addition compound; compound(chemical); solvate; pressure; phase(topology); diagram and table; object; liquid
CLASSIFICATION CODE(S): XD01030U

3/9/5
DIALOG(R)File 94:JICST-EPlus

02955989 JICST ACCESSION NUMBER: 95A0744455 FILE SEGMENT: JICST-E
Molecular Thermo-fluid-dynamics. Investigation for the Stability of CO2 Clathrate-Hydrate Using Molecular Dynamics Simulation.
HIRAI S (1); OKAZAKI K (1); KURAOKA S (1); KAWAMURA K (1)
(1) Tokyo Inst. Technol., Tokyo, JPN
Therm Sci Eng, 1995, VOL.3,NO.3, PAGE.69-74, FIG.7, TBL.1, REF.9
JOURNAL NUMBER: L1615AAS ISSN NO: 0918-9963
UNIVERSAL DECIMAL CLASSIFICATION: 544.142/.144
LANGUAGE: English COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
ABSTRACT: The stability of carbon dioxide clathrate hydrate which is the crystal solid in which the water molecule seems to be tied by the hydrogen combineding by making cage grid structure filled up in the carbon dioxide molecule, is examined by the molecular dynamics simulation. Result shows that the clathrate hydrate of the carbon dioxide is more unstable than that of nitrogen and argon. This paper explaines the reason for this instability on basis of the database which obtain from simulation.
DESCRIPTORS: hydrate; clathrate compound; carbon dioxide; argon; molecular dynamics; numerical calculation; stability analysis; interatomic potential
BROADER DESCRIPTORS: solvate; addition compound; compound(chemical); molecular compound; carbon oxide; oxide; chalcogenide; oxygen group element compound; oxygen compound; carbon compound; carbon group element compound; rare gas; element; third row element; dynamics; calculation; analysis; potential
CLASSIFICATION CODE(S): CE02000C

3/9/10
DIALOG(R)File 94:JICST-EPlus

02261926 JICST ACCESSION NUMBER: 95A0139281 FILE SEGMENT: PreJICST-E
Diffusion of CO2 Gas and its Transformation to Clathrate Crystals in Polar Ice Sheets.
MAE SHINJI (1)
(1) Hokkaido Univ., Fac. of Eng.
Asahi Garasu Zaidan Josei Kenkyu Seika Hokoku(Reports of Researches Assisted by the Asahi Glass Foundation), 1994, VOL.1994, PAGE.583-590
JOURNAL NUMBER: G0061BAQ ISSN NO: 0919-9179 CODEN: AGSHE
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
MEDIA TYPE: Printed Publication

ABSTRACT: Microscopic observation of air-hydrate crystals were carried out with ice core samples retrieved at Vostok Station, Antarctica. It was found that the volume and number of air-hydrate varied with the climatic change. For example, the number concentration of air-hydrate crystals was about half in the interglacial ice compared with that in the glacial ice. The mean volume gradually increased as the depth increased and this means that the gas molecules can diffuse in the ice and their rearrangement takes place. Formation investigation of air-hydrate crystals shows that the nucleation of the crystals at the boundaries between ice and air is most predominant mechanism in the transformation process from air to air-hydrate crystals. (author abst.)

3/9/13
DIALOG(R)File 94:JICST-EPlus

02142984 JICST ACCESSION NUMBER: 94A0130684 FILE SEGMENT: JICST-E
Rresearch on the fixation technology of carbon dioxide by clathrate and hydrate.
SAJI AKIRA (1); NODA HIDETOMO (1); TANII TADAAKI (2); KAMATA TOSHIHIRO (3); KITAMURA HIKARU (3)
(1) Chubu Electric Power Co., Ltd.; (2) Mitsubishi Heavy Industries, Ltd., Takasago Technical Inst.; (3) Mitsubishi Heavy Industries, Ltd., Kobe Shipyard and Engine Works
Kagaku Kogaku Shinpojiumu Shirizu, 1993, VOL.38, PAGE.143-148, FIG.10, REF.19
JOURNAL NUMBER: F0807BAP
UNIVERSAL DECIMAL CLASSIFICATION: 628.52/.53 614.777:628.19:551.464
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Conference Proceeding
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
ABSTRACT: Generation principle supporting experiment, continuous generation experimentand sedimentation experiment of CO2 clathrate (CC) were carried out in order to examine the system which stores large amount of CO2 recovered from thermal power plants in deep-sea floor, and generation and sedimentation characteristics of CC which is reaction product between CO2 and water were obtained. The generation speed of CC was in proportional to CO2 - water interface , continuous generation and separation of 10-20mm size CC were possible, and it was proven that sedimentation velocity increased with the increase in particle size.
DESCRIPTORS: carbon dioxide; clathrate compound; hydrate; thermal power generation; power plant; gas recovery; undersea storage; system evaluation; reaction product; reaction rate; fugacity; particle size(diameter); settling tank; settling velocity
BROADER DESCRIPTORS: carbon oxide; oxide; chalcogenide; oxygen group element compound; oxygen compound; carbon compound; carbon group element compound; molecular compound; addition compound; compound(chemical); solvate; power generation; electric power energy operation; electric power facility; recovery; storage; evaluation; product material; velocity; activity(thermodynamics); thermodynamic property; diameter; length; geometric quantity; chemical equipment; equipment
CLASSIFICATION CODE(S): SC04040S; SB02040B

3/9/15
DIALOG(R)File 94:JICST-EPlus

01833600 JICST ACCESSION NUMBER: 93A0429357 FILE SEGMENT: JICST-E
Recent heat pumps and applications. Technological trends in the development of electric and gas HPs. Ice-unused heat storage system. Clathrate heat-storage heat pump system.
SUZUKI MICHIYA (1)
(1) Shimizu Construction Co., Ltd.
Shoenerugi(Energy Conservation), 1993, VOL.45,NO.4, PAGE.66-68, FIG.2, TBL.3
JOURNAL NUMBER: F0218ACY ISSN NO: 0387-1819
UNIVERSAL DECIMAL CLASSIFICATION: 621.577: 628.8+697.9 620.9.004.4
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Commentary
MEDIA TYPE: Printed Publication
ABSTRACT: This paper presents an introduction example of a heat-storage heat pump system using clathrate made up of CFC-11 and water as the cold heat storage material. Clathrate is formed at 8.5.DEG.C. and is a fluid. The heat-storage heat pump system was designed to be responsible for about 50% of a peak air-conditioning load for an office building with a total floor area of 8,480m2.Operation performance for 102 days in the summer showed a midnight power utilization of 35%.
DESCRIPTORS: heat pump; heat storage; energy storage; clathrate compound; heat storage material; freon; thermal storage tank; heat exchanger; coefficient of performance; cold; air conditioning equipment
BROADER DESCRIPTORS: thermal operating device; storage and accumulation; storage; molecular compound; addition compound; compound(chemical); material; aliphatic chlorine compound; aliphatic halogen compound; organohalogene compound; organochlorine compound; aliphatic fluorine compound; organofluorine compound; storage tank; container; coefficient

; heat; equipment
CLASSIFICATION CODE(S): PC03020M; LC02000F

3/9/19
DIALOG(R)File 94:JICST-EPlus
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01411358 JICST ACCESSION NUMBER: 91A0560804 FILE SEGMENT: JICST-E
Study on Air Conditioning System Using the Clathrate Thermal Storage.
MIYAJI SHOZO (1); KOJIMA SHIN (2); KONDO FUMIO (2); YAMANAKA TOSHIHIKO (2); ISAKA YASUO (2); MAKINO TAKASHI (2)
(1) Chubu Electric Power Co., Ltd.; (2) Mitsubishi Heavy Industries, Ltd.
Nippon Dennetsu Shinpojiumu Koen Ronbunshu, 1991, VOL.28th,NO.Pt 2, PAGE.607-609, FIG.7, TBL.1, REF.2
JOURNAL NUMBER: F0872CAE
UNIVERSAL DECIMAL CLASSIFICATION: 628.81/.84:697.1/.7:697.9
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Conference Proceeding
ARTICLE TYPE: Short Communication
MEDIA TYPE: Printed Publication
ABSTRACT: This paper discusses the high-performance thermal storage tank for the air conditioning system using a gas hydrate, what is called a "clathrate", which is formed from the mixtures of cooled water and hydrating agent. In the thermal storage tank, the clathrate is formed, stored and also dissolved. For making thermal storage tank more efficient and smaller, we have analized the flow in the tank and found the proper arrangement of heat exchangers and agitators. Based on the results, an experimental unit with the high-performance thermal storage tank has been manufactured and tested. The clathrate packing factor in the tank has become greater than 40%. This proves that the "clathrate" thermal storage system has the asvantage of the conventional ice thermal storage systems. (author abst.)
DESCRIPTORS: air conditioning equipment; energy system; thermal storage tank; clathrate compound; agitated equipment; overall heat transfer coefficient; accelerated test; heat transfer medium
BROADER DESCRIPTORS: equipment; system; storage tank; container; molecular compound; addition compound; compound(chemical); machinery; mixing equipment; heat transmission coefficient; coefficient; ratio; test
CLASSIFICATION CODE(S): PC02010U

3/9/23
DIALOG(R)File 94:JICST-EPlus
(c)1997 Japan Science and Tech Corp(JST). All rts. reserv.

00908782 JICST ACCESSION NUMBER: 89A0465919 FILE SEGMENT: JICST-E
Utilization of clathrate hydrates for strage of gas.
HONDO TAKEO (1); ANZAI HIDENORI (1); AZUMA NOBUHIKO (1); GOTO AKIRA (1); MAE SHINJI (1)
(1) Hokkaido Univ., Faculty of Engineering
Kanchi Gijutsu Shinpojiumu Koen Ronbunshu, 1988, VOL.1988, PAGE.562-566, FIG.3, TBL.3, REF.3
JOURNAL NUMBER: X0501AAF
UNIVERSAL DECIMAL CLASSIFICATION: 624.14+.139
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Conference Proceeding
ARTICLE TYPE: Commentary
DESCRIPTORS: ice; clathrate compound; hydrate; hydrophobic; gas; safety; crystal structure; property; utilization; CA storage
BROADER DESCRIPTORS: molecular compound; addition compound; compound(chemical); solvate; structure; preservation(food); storage; conservation
CLASSIFICATION CODE(S): RC03000S
?s forefront(f)methane(w)hydrate/ti
2370 FOREFRONT
1908 METHANE/TI
415 HYDRATE/TI
S4 13 FOREFRONT(F)METHANE(W)HYDRATE/TI
?t 4/9/2,3,4,8; t 4/9/4,6,7,10,11,13
5

4/9/2
DIALOG(R)File 94:JICST-EPlus
(c)1997 Japan Science and Tech Corp(JST). All rts. reserv.

03553546 JICST ACCESSION NUMBER: 96A0894440 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Promotion and interference of the hydration of methane by additives.
OKUI TOSHIHARU (1); KAWASAKI TATSUJI (1); MAEDA YURIKO (1); KONDO TAKEHIKO (1)
(1) Tokyogasu Furontiatekunorojiken
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.690-694, FIG.3, REF.23
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 551.14:547
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication

DESCRIPTORS: methane gas; hydrate; additive; reaction rate; pressurization(apply); chemical equilibrium; chemical synthesis; natural gas
BROADER DESCRIPTORS: combustible gas; solvate; addition compound; compound(chemical); admixture; material; velocity; operation(processing); equilibrium; chemical reaction; synthesis
CLASSIFICATION CODE(S): DD01043K

4/9/3
DIALOG(R)File 94:JICST-EPlus

03553545 JICST ACCESSION NUMBER: 96A0894439 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Occurrence and resources of methane hydrate distributed in Sea of Okhotsk. Review.
ODA HIROSHI (1)
(1) Univ. of Tokyo, Grad. Sch.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.675-679, FIG.2, REF.8
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 553.981/.982
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Review article
MEDIA TYPE: Printed Publication
DESCRIPTORS: submarine sediment; hydrate; methane gas; Sea of Okhotsk; reserves of petroleum; natural gas
BROADER DESCRIPTORS: sediment; solvate; addition compound; compound(chemical); combustible gas; Northwest Pacific Ocean; North Pacific Ocean; Pacific Ocean; name of oceans
CLASSIFICATION CODE(S): DE09050D

4/9/4
DIALOG(R)File 94:JICST-EPlus

03553544 JICST ACCESSION NUMBER: 96A0894438 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Heat flow of the Kumano trough gotten from gas-hydrate BSR.
AKAZAWA YASUHIKO (1); ASHI JUICHIRO (2); TOKUYAMA EIICHI (3)
(1) Shizuokakyoikuse; (2) Univ. of Tokyo, Grad. Sch.; (3) Ocean Res. Inst., Univ. of Tokyo
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.660-666, FIG.5, REF.19
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 550.36+551.21 551.35
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: hydrate; natural gas; ocean trough; submarine sediment; terrestrial heat flow; reflection survey; reflection plane; Northwest Pacific Ocean
BROADER DESCRIPTORS: solvate; addition compound; compound(chemical); ocean basin; basin(geomorphology); geomorphic element; sediment; flow rate; seismic exploration; geophysical exploration; exploration; investigation; face; North Pacific Ocean; Pacific Ocean; name of oceans
CLASSIFICATION CODE(S): DC03070D; DE06000F

4/9/8
DIALOG(R)File 94:JICST-EPlus

03553305 JICST ACCESSION NUMBER: 96A0885124 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Basic research of natural gas production and the sea bottom isolation of carbon dioxide. Elucidation of structure and physical property of the gas inclusion compound.
OGAKI KAZUNARI (1); MATSUBARA TAKUYA (1); NAKANO SHIN'YA (1)
(1) Osaka Univ., Fac. of Eng. Sci.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.685-689, FIG.6, REF.7
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 551.14 622.24.085.5
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: clathrate compound; carbon dioxide; submarine sediment; mixed gas; phase equilibrium; reaction rate; ocean floor resource; submarine mining
BROADER DESCRIPTORS: molecular compound; addition compound; compound(chemical); carbon oxide; oxide; chalcogenide; oxygen group element compound; oxygen compound; carbon compound; carbon group element compound; sediment; gas; mixture; object; equilibrium; velocity ; mineral resource; resource; underwater mining; mining operations
CLASSIFICATION CODE(S): DD01041C; UA09030M

4/9/5
DIALOG(R)File 94:JICST-EPlus

03553543 JICST ACCESSION NUMBER: 96A0894437 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. On the characteristics of BSR of Nankai Trough and the offing of Abashiri.
SAKAI AKIO (1)
(1) Jpn. Pet. Explor. Co., Ltd.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.652-659, FIG.6, TBL.1, REF.14
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 550.834
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: ocean trough; Northwest Pacific Ocean; reflection plane; reflection survey; well logging; geothermal gradient; submarine sediment
IDENTIFIERS: Nankai Trough
BROADER DESCRIPTORS: ocean basin; basin(geomorphology); geomorphic element; North Pacific Ocean; Pacific Ocean; name of oceans; face; seismic exploration; geophysical exploration; exploration; investigation; temperature gradient; gradient; sediment
CLASSIFICATION CODE(S): DE10030B

4/9/6
DIALOG(R)File 94:JICST-EPlus

03553307 JICST ACCESSION NUMBER: 96A0885126 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Analysis of the methane hydrate natural sample using X-ray CT and NMR. Example of the natural sample gotten from ODP Leg164.
UCHIDA TAKASHI (1); YAMAMOTO JUNJI (1); OKADA SHIN'ICHI (1); OKATSU KOMEI (2)
(1) Jpn. Pet. Explor. Co., Ltd., JAPEX Res. Cent.; (2) Technol. Res. Center Jpn. Natl. Oil Corp.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.704-709, FIG.5, TBL.1, REF.4
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 551.14:547
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: hydrate; methane gas; submarine sediment; Northwest Atlantic Ocean; boring core; excavation; X-ray computed tomography; 13C NMR; natural gas
BROADER DESCRIPTORS: solvate; addition compound; compound(chemical); combustible gas; sediment; North Atlantic Ocean; Atlantic Ocean; name of oceans; geological sample; sample; X-ray inspection; radiographic inspection; nondestructive inspection; inspection; computed tomography; diagnostic imaging; diagnosis; tomography; image technology; technology ; radiography; NMR; magnetic resonance; resonance
CLASSIFICATION CODE(S): DD01043K

4/9/7
DIALOG(R)File 94:JICST-EPlus

03553306 JICST ACCESSION NUMBER: 96A0885125 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Methane hydrate synthesis experiment and examination of the stable condition.
MAEKAWA TATSUO (1); IMAI NOBORU (1)
(1) Geol. Surv. of Jpn., Agency of Ind. Sci. and Technol.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.695-699, FIG.2, REF.11
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 551.14
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: methane gas; hydrate; natural gas; chemical synthesis; sodium chloride; aqueous solution; stability constant
BROADER DESCRIPTORS: combustible gas; solvate; addition compound; compound(chemical); chemical reaction; synthesis; alkali metal halide; alkali metal compound; halide; halogen compound; chloride; chlorine compound; sodium compound; solution(liquid); liquid; chemical equilibrium; equilibrium
CLASSIFICATION CODE(S): DD01041C

4/9/10
DIALOG(R)File 94:JICST-EPlus

03553303 JICST ACCESSION NUMBER: 96A0885122 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Collapse sediment observed in the Amazon submarine fan. Dissolution of gas-hydrate and slope failure.
SO UON (1); SUZUKI KIYOFUMI (1); OKATSU KOMEI (2)
(1) Kyushu Univ., Faculty of Science; (2) Technol. Res. Center Jpn. Natl. Oil Corp.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.667-674, FIG.5, TBL.2
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 551.35
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: submarine fan; submarine sediment; slope failure; hydrate; natural gas; dissolution; debris flow; South America; river
IDENTIFIERS: Amazon
BROADER DESCRIPTORS: alluvial fan; geomorphic element; sediment; decay; solvate; addition compound; compound(chemical); Americas
CLASSIFICATION CODE(S): DE06000F

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DIALOG(R)File 94:JICST-EPlus
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03553302 JICST ACCESSION NUMBER: 96A0885121 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Physical property measurement, well logging and BSR of the breaking ridge transect.
SATO MIKIO (1)
(1) Geol. Surv. of Jpn., Agency of Ind. Sci. and Technol.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.647-652, FIG.4, REF.6
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 550.834
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Original paper
MEDIA TYPE: Printed Publication
DESCRIPTORS: hydrate; natural gas; well logging; boring core; petrophysical property; reflection plane; reflection survey; oceanic ridge; Northwest Atlantic Ocean; submarine sediment
BROADER DESCRIPTORS: solvate; addition compound; compound(chemical); exploration; investigation; geological sample; sample; lithologic character; property; face; seismic exploration; geophysical exploration ; geomorphic element; North Atlantic Ocean; Atlantic Ocean; name of oceans; sediment
CLASSIFICATION CODE(S): DE10030B

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DIALOG(R)File 94:JICST-EPlus
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03553300 JICST ACCESSION NUMBER: 96A0885119 FILE SEGMENT: JICST-E
Forefront of the methane hydrate research. Followings are investigated : Solid methane and gas-hydrate under the sea bottom. Perspective on the results of ODPLeg164 and the research about methane hydrate.
MATSUMOTO RYO (1)
(1) Univ. of Tokyo, Grad. Sch.
Gekkan Chikyu(Chikyu Monthly), 1996, VOL.18,NO.10, PAGE.633-639, FIG.6, REF.5
JOURNAL NUMBER: L0342AAU ISSN NO: 0387-3498
UNIVERSAL DECIMAL CLASSIFICATION: 553.981/.982 551.14:547
LANGUAGE: Japanese COUNTRY OF PUBLICATION: Japan
DOCUMENT TYPE: Journal
ARTICLE TYPE: Review article
MEDIA TYPE: Printed Publication
DESCRIPTORS: methane gas; hydrate; submarine sediment; excavation; boring core; Northwest Atlantic Ocean; international cooperation; natural gas
BROADER DESCRIPTORS: combustible gas; solvate; addition compound; compound(chemical); sediment; geological sample; sample; North Atlantic Ocean; Atlantic Ocean; name of oceans; cooperation(partnership)
CLASSIFICATION CODE(S): DE09050D; DD01043K
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17apr97 07:43:25 User006713 Session D2915.3
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