April 14, 2000

Victor Jones
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Houston, TX 77042

Dear Vic:

I have done a quick review, in the short time available, of the newly acquired data from the Playa Vista site. Although I have looked at a number of different parameters within the data set, I do not have time to go into great detail now. To help demonstrate my observations I am enclosing three figures. Figure 1 is a plot similar to plots that I have sent you in the past which shows the carbon and hydrogen isotopic compositions of the methane samples from this study relative to typical compositional ranges of gases from different sources. As you can see, most of the samples fall along a zone stretching from the sub surface microbial gas zone into the edge of the thermogenic gas zone. This zone, I believe, represents different mixtures of thermogenic gas and biogenic methane. Another group of samples falls above this zone.   Those samples represent gases that have been subjected to bacterial oxidation affects. As a matter of fact, there are two more samples which do not appear on this plot because they are off scale, above the plot.

The second figure enclosed is the same data at an expanded scale to show more detail, and including all of the samples from this group. Again, we see a spread of samples along a horizontal trend which appears to indicate mixtures of biogenic methane and thermogenic methane.   There are a number of samples which cluster near the right end of this trend, and these samples are the ones which have the least, if any biogenic methane with them.

There is also a very strong vertical trend on this figure. These samples are believed to have been strongly affected by bacterial oxidation. Shown on the figure is a V shaped arrow indicating possible oxidation affects. The right hand arm of the V is the trend that we normally observe for methane oxidation effects. However, with the current data set, it appears that oxidation is strongly affecting the hydrogen isotope composition with little if any affect on the carbon isotope composition. The result is a shift in a vertical direction, approximately parallel to the left leg of the V. This appears to be a very strong trend, but is different than what I have observed previously.   I should point out that it is not only this data that is used to draw the conclusion that these samples have been subjected to oxidation. This is also demonstrated by the oxygen deficiencies in the samples and the carbon isotopic composition of the carbon dioxide. One sample, well # 39, appears to have been strongly affected both by oxidation and mixing with biogenic methane.

The cluster of samples in the lower right hand corner of Figure 2 show the least affects of either methane oxidation and biogenic methane formation. In fact if we compare this data to the other available data for the samples, there appear to be three samples in particular that show the least secondary affects, and thus are the freshest thermogenic methane. These three are wells 153, 175, and 912. This suggests that there are two different locations within the study area where gas seeps exist. Assuming that the maps you sent me are laid out in a normal north-south east-west arrangement, it appears that there is one source of thermogenic methane in the southeast corner of the study area near wells 912 and 921, and the other is just southeast of the intersection of Lincoln Boulevard and Jefferson Boulevard.

Figure 3 is again the same data, but I have colored the sample markers differently to indicate three different groups of gases. The solid black dots represent relatively pure unaltered thermogenic gas. Please note the term relative, as even some of these gases do appear to show some secondary affects. The open circles are those which represent mixtures of thermogenic gas and biogenic methane. Of course some of these samples are predominately thermogenic gas and some appear to be predominately biogenic gas. The third group of samples are shown as shaded dots and they represent gases that have been significantly altered by bacterial oxidation. Most of the samples which have been severely oxidized are thermogenic gases, but some of the biogenic mixtures also appear to have been subjected to some oxidation affects.

If one applies the coding shown on Figure 3 to the map that you sent me, there are some definite zones that can be identified. There are two zones which are relatively pure unaltered thermogenic gas centering around the wells identified previously. There is also a zone in between these two areas which contains bacterial methane or biogenic gas. There are also zones which appear to be predominately oxidized gases.

The relationship between the thermogenic gas seeps and the biogenic methane is somewhat difficult to understand, but is a phenomenon that I have observed previously. At another site that I worked on in Southern California, we appeared to find evidence of biogenic methane associated with natural gas seeps where those seeps were pure thermogenic gas. My explanation for this in the past was that with a natural seep such as we appear to have here, where gas has probably been coming to the surface for hundreds or thousands of years, there can be a very substantial culture of bacteria developed that lives on this gas. The interface between the oxic and anoxic zones can change depending upon hydrostatic conditions, barometric pressure, and the rate of gas seepage. Therefore a specific location that is anoxic at one time could be oxic at another time, or vice versa. If an oxic zone becomes anoxic, it seems reasonable to me that anoxic bacteria could consume the residual cell material present in that zone and convert it to methane. In simple words, I believe that the methanogens could be living on the dead methanotrophs. Therefore, the zones where we see biogenic gas today may have been, at some time in the past, the site of methane oxidation.

And another twist to this story is that last summer at the AAPG conference in Durango, Colorado, there was a paper given in which it was concluded that some methanogens are actually switch hitters. That is, under some conditions they can be methane producers whereas under other conditions they can be methane consumers. In particular the author, I believe, was referring to sulphate reducing bacteria. This is an intriguing idea because we have a great deal of field evidence that sulphate reducing bacteria can consume methane, yet the microbiologists have not been able to culture sulphate reducing bacteria that consume methane. The author's conclusion was, I believe, that the reason for this is that it is not sulphate reducing bacteria that are consuming methane, but that it is methanogens that are reducing sulphate. If it is this type of phenomena that is occurring at Playa Vista, that may also explain the lack of carbon isotope fractionation that we see associated with the methane oxidation. That is, this may be a site of anaerobic oxidation and not aerobic oxidation as we usually see. This would also suggest that the oxidation may actually be occurring at greater depth and not in the near-surface where our samples are collected.

With a previous group of samples from this area we observed trends in the ethane isotope data. However, for the current data set, which covers a much larger area, the trends are not so clear cut and thus I have not included that data in this discussion.

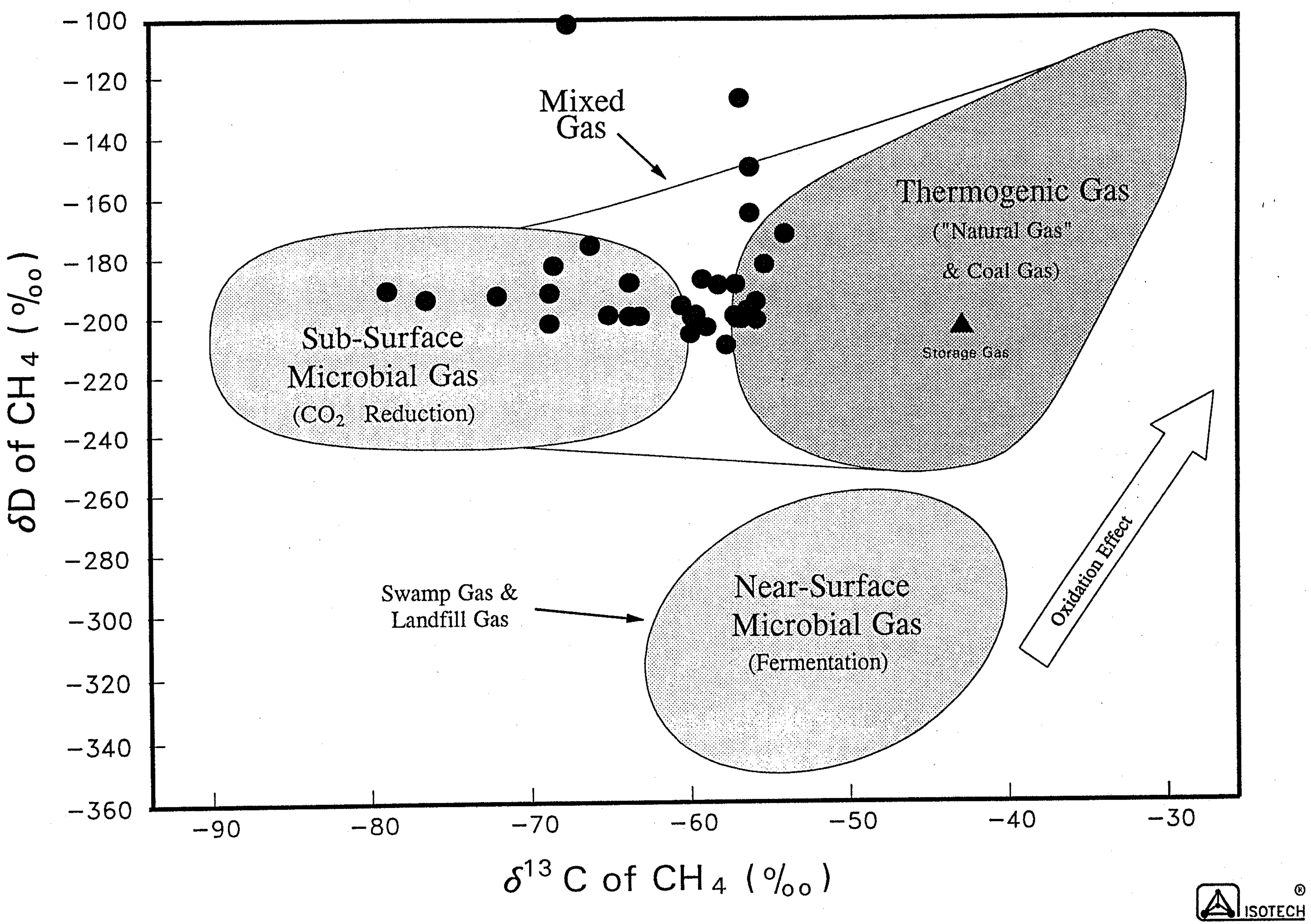
This is a fascinating set of data and I am sorry that I don't have more time to work with it, but I hope that my comments are helpful to you. Is I mentioned, I will be out of town next week, but will be back in the office on April 24th.

Sincerely Yours,

Dennis D. Coleman
Laboratory Director

DDC:lc
Enclosures

Figure 1


Mixed Gas
Thermogenic Gas
("Natural Gas"
& Coal Gas)
Storage Gas
Sub-Surface Microbial Gas
(CO_2 Reduction)
Swamp Gas & Landfill Gas
Near-Surface Microbial Gas
(Fermentation)
Oxidation Effect
−100
−120
−140
−160
−180
−200
−220
−240
−260
−280
−300
−320
−340
−360
−90
−80
−70
−60
−50
−40
−30
δD of CH_4 (‰)
$\delta^{13}C$ of CH_4 (‰)
ISOTECH

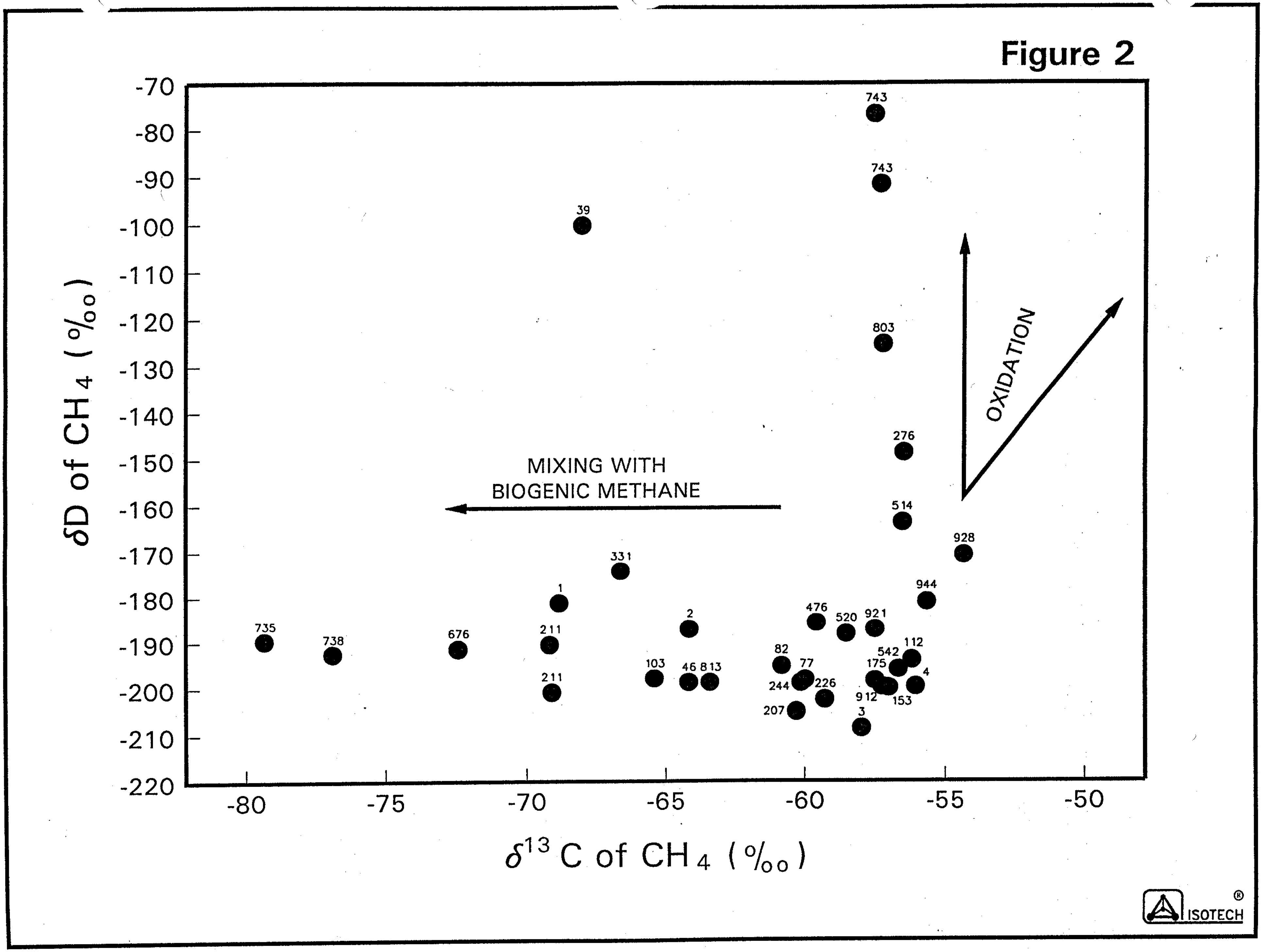
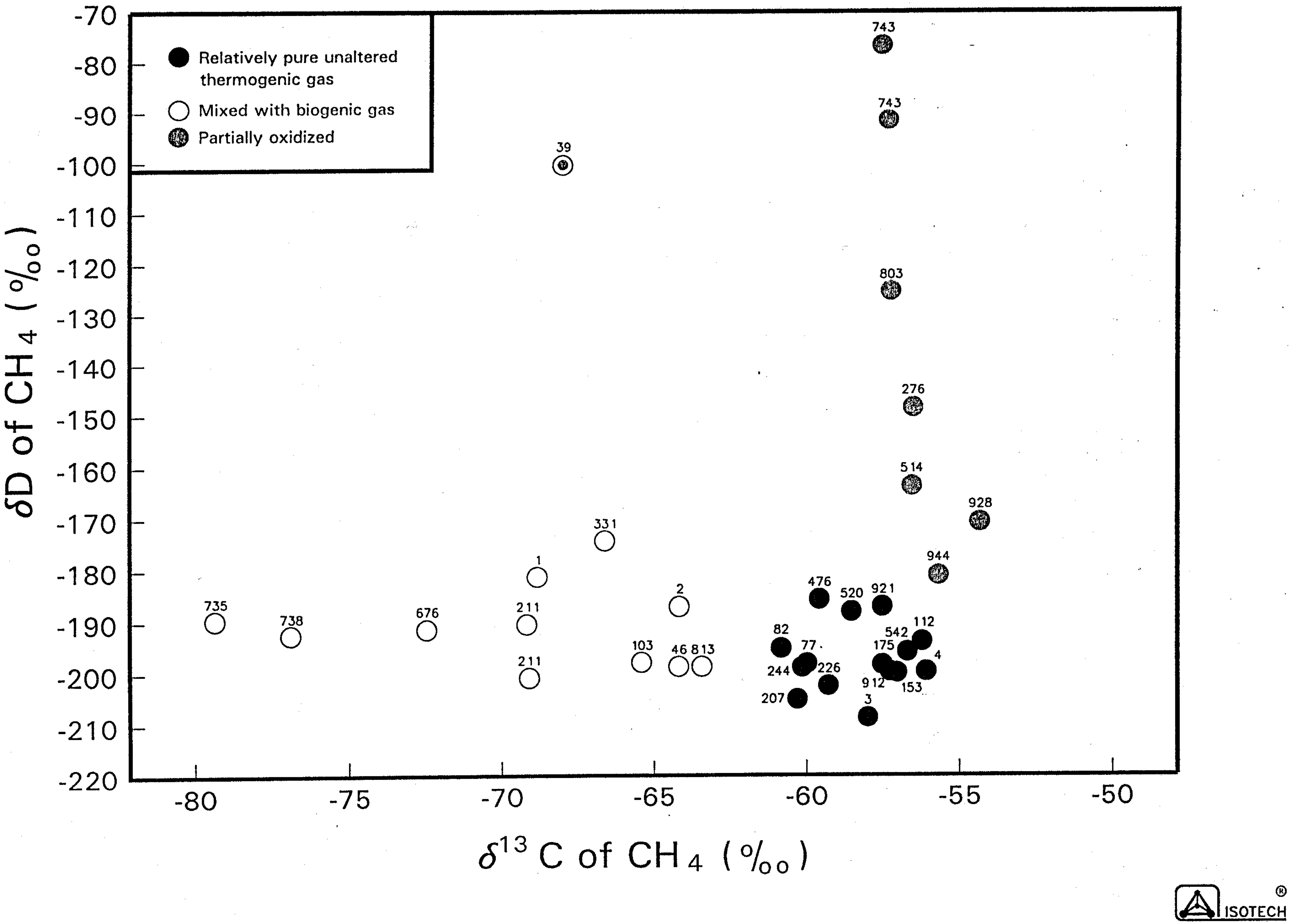


Figure 2
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
δD of CH4 (‰)
-80
-75
-70
-65
-60
-55
-50
δ13 C of CH4 (‰)
MIXING WITH
BIOGENIC METHANE
OXIDATION
743
743
39
803
276
514
928
331
1
944
2
476
520
921
735
738
676
211
211
103
46
813
82
77
244
226
207
3
542
112
175
4
912
153
ISOTECH

Figure 3



Relatively pure unaltered thermogenic gas
Mixed with biogenic gas
Partially oxidized
δD of CH4 (‰)
δ13C of CH4 (‰)
-70
-80
-90
-100
-110
-120
-130
-140
-150
-160
-170
-180
-190
-200
-210
-220
-80
-75
-70
-65
-60
-55
-50
743
743
39
803
276
514
928
331
944
1
476
921
520
2
735
211
738
676
112
542
82
77
175
103
46
813
4
244
226
211
912
153
207
3
ISOTECH