

**ALBERTA ENERGY AND UTILITIES BOARD**

**IN THE MATTER OF** the *Alberta Energy and Utilities Board Act*, R.S.A. 2000, c. A-17 (the “EUB Act”), and the regulations made thereunder; and

**IN THE MATTER OF** section 40(1) of the *Energy Resources Conservation Act*, R.S.A. 2000, c. E-10, (the “ERC Act”) and the regulations made thereunder; and

**IN THE MATTER OF** Part 2 of Proceeding No. 1457147, Bears paw Petroleum Ltd. (“Bears paw”), Carbon Development Partnership (Successor in Interest to Prairie Mines and Royalties Ltd., Formerly Luscar Ltd.) (“CDP”), Devon Canada Corporation (“Devon”), EnCana Corporation (“EnCana”), and Fairborne Energy Ltd. (“Fairborne”), in relation to the Clive, Ewing Lake, Stettler and Wimborne Fields; and

**IN THE MATTER OF** Alberta Energy and Utilities Board (“EUB” or “Board”) Bulletin 2006-19 (“Bulletin 2006-19”); and

**IN THE MATTER OF** EUB Notice of Hearing dated June 23, 2006 (“Notice of Hearing”); and

**IN THE MATTER OF** EUB letter to Legal Counsel dated July 27, 2006 (“Letter to Counsel”).

**JOINT REPLY ARGUMENT OF  
CONOCOPHILLIPS CANADA RESOURCE CORP.  
 (“ConocoPhillips Canada”), DEVON CANADA  
 CORPORATION (“Devon”), FAIRBORNE  
 ENERGY LTD. (“Fairborne”), QUICKSILVER  
 RESOURCES CANADA INC. (“QuickSilver”),  
 CANPAR HOLDINGS LTD. (“Canpar”), and  
 CENTRICA CANADA LIMITED (“Centrica”)**

**DECEMBER 13, 2006**

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**JOINT TECHNICAL REPLY OF  
THE NATURAL GAS RIGHTS HOLDERS**

**I. INTRODUCTION**

1. Devon, Fairborne, ConocoPhillips Canada, Quicksilver, Canpar, and Centrica (collectively referred to as the “Natural Gas Rights Holders”) provide this joint written reply argument (the “Joint Technical Reply”) on technical and scientific issues pertaining to coal and gas stored in coal<sup>1</sup> raised in the Final Arguments of Carbon Development Partnership (“CDP”) and EnCana Corporation (“EnCana”) (collectively, the “Coal Owners”) pursuant to Part 2 of Proceeding No. 1457147 (“Proceeding No. 1457147”).<sup>2</sup>
2. The Coal Owners’ arguments, in an attempt to characterize gas stored in coal as a rock, manufacture complexity where none exists. They ignore the relevant facts about the behaviour of methane mixtures, mischaracterize adsorption and are simply wrong on matters of physical bonding. Furthermore, several of the Coal Owners’ arguments are little more than unfair and groundless attacks on Mr. Mavor’s credibility that all too conveniently ignore scientific fact and procedural fairness.
3. This Joint Technical Reply addresses the following:
  - the Coal Owners’ assertions that adsorption makes the gas coal;
  - the technical aspects of the attempts by the Coal Owners to discredit Mr. Mavor; and
  - the irrelevance of the Coal Owners’ arguments regarding the behaviour of methane mixtures.

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<sup>1</sup> The terms coalbed gas, gas in coal, gas from coal, coalbed methane or “CBM” within the context of Proceeding No. 1457147 are all intended to refer to and describe natural gas stored in coal. Despite the comments made by CDP at paragraph 20 of its final argument, it is not uncommon to refer to CBM as “natural gas stored in coal”. See, for instance, the article listed at page 87 of Dr. Levine’s Report, Exhibit 19-002-2006-09-15, Levine, J.R., 1991, The impact of oil formed during coalification on generation and **storage of natural gas in coal bed reservoir systems: 3<sup>rd</sup> Coalbed Methane Symp. Proc.**, Tuscaloosa, AL, May 13-16, 1991, p. 307-315.

<sup>2</sup> Proceeding No. 1457147 involves a review, at the request of EnCana and CDP, of the Board’s previous decisions on Bears paw, Devon and Fairborne applications for well licenses, special gas well spacing and compulsory pooling orders. As part of that review a substantial amount of evidence has been led concerning the characteristics of coal and gas in coal.

4. The Natural Gas Rights Holders file this Joint Technical Reply concurrently with separate and individual company reply submissions on all other matters at issue in Proceeding No. 1457147. The extreme unfairness of the Coal Owners referring to U.S. Patent US 6,412, 559 B1 (the "Sequestration Patent") and other similar evidence for the first time in their final arguments is addressed in individual company reply submissions. However, without intending to detract from those submissions nor to agree that the Sequestration Patent should be admissible as evidence in this proceeding, this Joint Technical Reply includes technical submissions in respect of the Sequestration Patent.

## **II. ADSORPTION DOES NOT MAKE THE GAS COAL**

5. EnCana asserts that the "... single inexorable fact which establishes that CBM is a constituent of coal" is the fact that more methane can be stored in the coal than would be possible by compression alone.<sup>3</sup> This assertion is, quite simply, ridiculous – especially in light of the testimony of both Mr. Mavor and Dr. Levine concerning adsorption phenomena.<sup>4</sup>
6. Adsorption theories describe attraction between solid material and vapour and clearly differentiate between the two substances. As discussed throughout the testimony of both Mr. Mavor and Dr. Levine, there is a weak physical attraction between the CBM and the coal organic material. This weak physical attraction causes the molecules to pack more closely together than would be the case if the organic material were not present. However, contrary to EnCana's unsupported assertions, this weak physical attraction does not cause the CBM and the coal to be "united or one"<sup>5</sup> any more than does a magnet become "united or one" with a refrigerator door or the child's drawing that it holds to it.<sup>6</sup>
7. The Coal Owners also erroneously suggest that adsorption and diffusion distinguish coal from other reservoir rock types.<sup>7</sup> They do so in order to support their assertion that CBM is a

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<sup>3</sup> EnCana Final Argument, November 29, 2006, page 20, para. 92.

<sup>4</sup> Mr. Mavor Evidence: See Exhibit 18-001-2006-08-25, Mavor Report, page 12, paras. 6-7, Tr. Vol. 2, page 156, lines 2-20, and page 319, lines 4-8; Dr. Levine Evidence: See Exhibit 19-002-2006-09-15, Dr. Levine Report, page 65, para. 4 and page 71, section 5.1.2; Tr. Vol. 6, page 814, line 14 to page 818, line 9, and page 826, line 1 to page 828, line 10; Tr. Vol. 7, page 939, lines 5-16.

<sup>5</sup> EnCana Final Argument, November 29, 2006, page 20, para. 96

<sup>6</sup> Nor does the magnet become part of the refrigerator itself.

<sup>7</sup> CDP Final Argument, November 29, 2006, pages 40-41, para. 97.

constituent of coal. In fact, the mechanisms of adsorption and diffusion are not unique to coal and do not preclude a finding that CBM exists as gas *in situ* in an undisturbed reservoir.

8. As Mr. Mavor testified, adsorption occurs in a variety of rock types including Atrium Shale, Barnett Shale, Devonian Shale, Lewis Shale, and New Albany Shale, as well as in zeolites and a variety of materials including silica gel, activated alumina, activated carbon, and illite clay.<sup>8</sup> Adsorption is thus not unique to coal.<sup>9</sup>
9. Nor are CBM flow mechanisms unique to coal. In this regard, CDP is incorrect when it suggests that Mr. Mavor stated that CBM reservoirs have “low to negligible primary porosity in the coal matrix itself.”<sup>10</sup> In fact, Mr. Mavor testified that it is the coal matrix *permeability* that is negligible, not the porosity.<sup>11</sup>

### **III. THE COAL OWNERS' ATTACKS ON MR. MAVOR'S CREDIBILITY ARE ENTIRELY WITHOUT MERIT**

10. The Coal Owners attack Mr. Mavor's credibility with respect to:

- the composition of coal before and after extraction;
- consistency between the Sequestration Patent and his testimony regarding natural gas storage and flow; and
- Mr. Mavor's experience and expertise.

#### **A. The Coal Owners Mischaracterize the Composition of Coal Before and After Extraction**

11. Mr. Mavor's evidence clearly indicates that CBM is a gas *in situ* in an undisturbed reservoir. The Coal Owners are simply attempting to manufacture confusion on the issue by suggesting otherwise.<sup>12</sup>

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<sup>8</sup> Exhibit 18-001-2006-08-25, Mavor Report, page 13, para. 4.

<sup>9</sup> The dual porosity reservoir mathematical models Mr. Mavor used to describe CBM storage and flow were based upon models for rock types other than coal. See Exhibit 18-001-2006-08-25, Mavor Report, page 7, para. 4.

<sup>10</sup> CDP Final Argument, November 29, 2006, page 41, paragraph 98.

<sup>11</sup> Exhibit 18-001-2006-08-25, Mavor Report, page 7, para. 1 and Tr. Vol. 2, page 205, line 16 to page 206, line 11.

<sup>12</sup> CDP Final Argument, November 29, 2006, pages 40-41, para. 97.

12. Both EnCana and CDP contend that ease of extraction of gas stored in coal does not differentiate it from the constituents of coal. This position conveniently ignores the fact that the constituents of coal, namely organic material, inherent moisture, and mineral matter cannot be extracted without one or a combination of: (i) mechanical failure of the coal; (ii) alteration of subsurface samples removed to the surface; (iii) crushing or drying; or (iv) mining. The differences are real, significant, and must not be ignored.

**B. Mr. Mavor's Evidence is Consistent with the Sequestration Patent**

13. It is extremely unfair that the Coal Owners would attempt, as they have, to impeach Mr. Mavor's credibility without first putting the supposed inconsistency between his testimony and the Sequestration Patent to him in cross-examination. Further submissions in that regard are made in individual company reply arguments. The fact is, however, that Mr. Mavor's testimony and the Sequestration Patent are entirely consistent.

14. In particular, the Sequestration Patent states that "the equivalent density of the molecules in the sorbed state is similar to the density of the molecules in a liquid state."<sup>13</sup> There is no inconsistency between that statement and Mr. Mavor's testimony which was, in essence, that adsorbed CBM exists, *in situ*, as a dense vapour.<sup>14</sup> Indeed, not even Dr. Levine said that adsorbed CBM exists in a liquid state. Rather, he used the ambiguous phrase "liquid-like". Inherent in the phrase "liquid-like" is the inescapable fact that adsorbed CBM exists not in a liquid state but in a state which, because of its density, is "like" a liquid. The two states are different.

15. The Sequestration Patent also discusses differences between conventional natural gas reservoirs and coalbed methane reservoirs. Specifically, the Sequestration Patent includes descriptions of differences in gas storage by adsorption and swelling of the rock matrix due to adsorption. Mr. Mavor discussed in his opening statement the coal matrix swelling phenomenon that results in small changes in the coal matrix volume. That testimony was fully consistent with the Sequestration Patent.

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<sup>13</sup> CDP Final Argument, November 29, 2006, page 39, para. 93.

<sup>14</sup> Exhibit 18-001-2006-08-25, Mavor Report, page 20, para. 3; Tr. Vol. 2, page 232, line 21 to page 233, line 19.

**C. Mr. Mavor is an Authority in Coal Composition and Adsorption Mechanisms**

16. EnCana contends that Mr. Mavor is not sufficiently familiar with coal composition and adsorption mechanisms<sup>15</sup> for his evidence to be favoured over that of Dr. Levine.<sup>16</sup> This position is entirely unfair and ought to be rejected.
17. Mr. Mavor has been involved with the reservoir properties and behaviour of gas stored in coal since 1988. During this time, he has been involved with research efforts concerning coal organic composition and adsorption behaviour. As documented in his *curriculum vitae*, he has also published extensively on the subject and served as a technical expert in the *Amoco Production Co. v. Southern Ute Tribe*<sup>17</sup> case. Moreover, the Board accepted Mr. Mavor as an expert in these proceedings.
18. The Coal Owners suggest that Mr. Mavor's understanding of the *in situ* state of inherent moisture in coal is incomplete.<sup>18</sup> The fact is, however, that Mr. Mavor has studied and documented methods to determine and equilibrate isotherm coal samples at the inherent moisture content in detail.<sup>19</sup>
19. It should also be noted that the Coal Owners attempt to diminish Mr. Mavor's testimony by misquoting him. In particular, EnCana quotes Mr. Mavor as saying that “. . . the actual mechanism on how the gas is adsorbed is immaterial” but omits the remainder of the sentence, “. . . to these proceedings.”<sup>20</sup> Mr. Mavor goes on to clarify the statement: “No, it's actually immaterial to these proceedings, because we can describe the adsorption behaviour of a coalbed methane reservoir with a variety of laboratory measurements in which we do not have to assume any particular state, fluid density, or anything along those lines that we cannot determine at the atomic level.”<sup>21</sup>

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<sup>15</sup>EnCana Final Argument, November 29, 2006, page 23, para. 109(g).

<sup>16</sup>EnCana Final Argument, November 29, 2006, page 22, para. 108.

<sup>17</sup>*Amoco Production Co. v. Southern Ute Tribe*, 144 L. Ed. 2d 22 (US Supreme Court).

<sup>18</sup>EnCana Final Argument, November 29, 2006, page 23, para. 109(c).

<sup>19</sup>Tr. Vol. 2, page 330, line 18 to page 331, line 1.

<sup>20</sup>EnCana Final Argument, November 29, 2006, page 23, para. 109(f). See also, Tr. Vol. 3, page 354, lines 22-25.

<sup>21</sup>Tr. Vol. 3, page 355, lines 2-7.

#### **IV. COAL OWNERS' ARGUMENTS ON THE BEHAVIOUR OF METHANE MIXTURES ARE IRRELEVANT**

20. In their final arguments, the Coal Owners revisit the behaviour of methane and ethane mixtures and assert that such mixtures can exist as liquids at temperatures between the critical temperature of methane and the cricondenthem of the relevant mixture.<sup>22</sup> Even if this were true, it is irrelevant to the matters that are at issue here since the cricondenthem<sup>23</sup> of CBM, regardless of the specific constitution of the CBM, is far below the temperatures found in the relevant Alberta coal reservoirs.
21. Gas stored in coal is a mixture of methane and ethane with lesser amounts of propane, nitrogen, and carbon dioxide among other constituents. Methane is, by far, the predominant component. As demonstrated with references to mixtures of methane and ethane that include even greater relative proportions of ethane than found in the natural gas stored in Alberta coal seams,<sup>24</sup> the cricondenthem of gas stored in coal must be between the critical temperature of methane (-82.6 degrees C) and the cricondenthem for a 70%-30% mix of methane and ethane (-28 degrees C).<sup>25</sup> By way of comparison, temperatures observed in the Ardley and Mannville coal seams in Alberta range from 16 to 47 degrees C.<sup>26</sup>
22. Adsorbed methane is more correctly described as a dense gas at coal seam temperature conditions, as the adsorbed gas is far above both the critical temperature of methane and the cricondenthem of gas stored in coal.

#### **V. CONCLUSIONS**

23. The key facts established by technical and scientific evidence adduced in proceeding No. 1457147 and amply supported by the testimony of Mr. Mavor include:

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<sup>22</sup> EnCana Final Argument, November 29, 2006, Appendix pages 1-4.

<sup>23</sup> The cricondenthem is the maximum temperature at which a mixture, in this case gas stored in coal, can be a liquid. See Tr. Vol. 7, page 986, lines 12-19.

<sup>24</sup> Exhibit 20-045, Figure 2.4 Phase Diagram of Methane-Ethane Mixture; See generally, Tr. Vol. 7, page 985, line 2 to page 989, line 4.

<sup>25</sup> Tr. Vol. 7, page 968, line 19 to page 987, line 3.

<sup>26</sup> Natural Gas Rights Holders' Joint Technical Argument, November 15, 2006, page 5, para. 18. The temperatures in the Horseshoe Canyon coals fall within this range.

- coal is a solid rock that serves as a container for gas stored in it;
- gas stored in coal is separate and distinct both from the coal rock matrix itself and from the other coal materials that may be contained within that matrix;
- gas stored in coal is gaseous at *in situ* temperature and pressure conditions in Alberta coal seams;
- it is impossible for gas stored in coal in Alberta commercial coal seams to exist as a liquid; and
- gas stored in coal is a gas before and after human disturbance.

24. For the forgoing reasons and those set out in the November 15, 2006 Joint Argument of the Natural Gas Rights Holders, the evidence of Mr. Mavor should be preferred to that of Dr. Levine. Mr. Mavor's evidence expresses the accepted opinion on gas stored in coal. The evidence of Dr. Levine, which attempts to obfuscate and confuse the very simple point that CBM is a gas *in situ*, does not.

**ALL OF WHICH IS RESPECTFULLY SUBMITTED ON BEHALF OF THE NATURAL GAS RIGHTS HOLDERS THIS 13<sup>TH</sup> DAY OF DECEMBER, 2006.**

**CONOCOPHILLIPS CANADA RESOURCES  
CORP., DEVON CANADA CORPORATION,  
FAIRBORNE ENERGY LTD., QUICKSILVER  
RESOURCES CANADA INC., CANPAR  
HOLDINGS LTD., and CENTRICA CANADA  
LIMITED**

**Per:**

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**Alan L. Ross**

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